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The TECHNICAL WORLD

VOL. I JUNE, 1904 No. 4

LEADING ARTICLES THIS MONTH

Development of Armor and Ordnance, *By* W. S. LELAND, S. B., *Massachusetts Institute of Technology.*

Electrical Features of the St. Louis Exposition *By* CALE GOUGH

Mechanical Refrigeration . . . . . *By* OSWALD GUETH, M. E.

How Electricity is Taught at Tuskegee, *By* CHAS. W. PIERCE, B. S.

Economy of High-Speed Steel . . . *By* FREDERICK W. TURNER

Methods of Moulding . . . . . *By* JAMES RITCHEY

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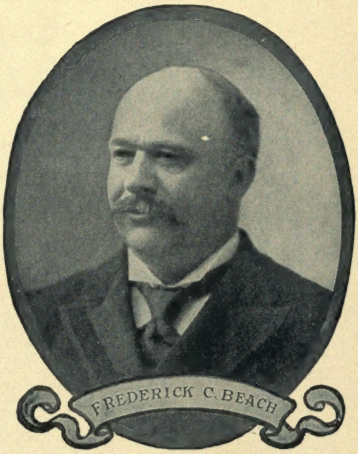

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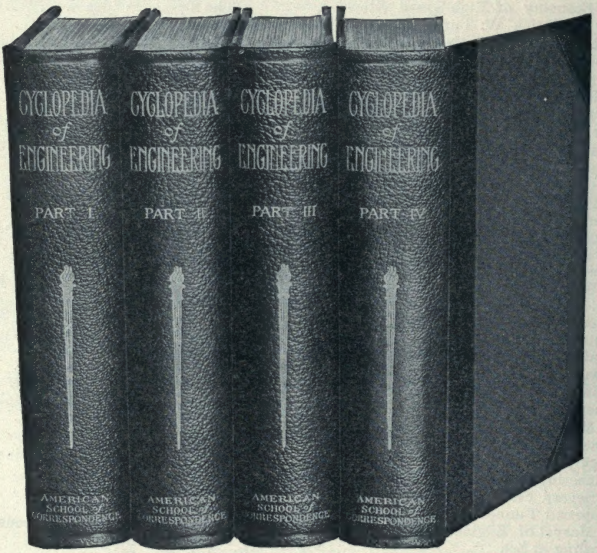

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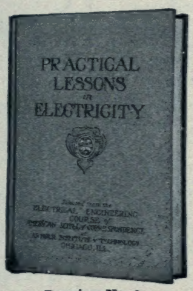

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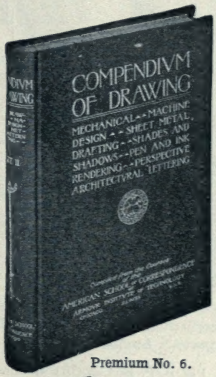

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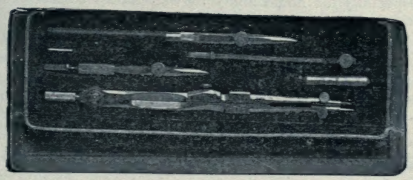
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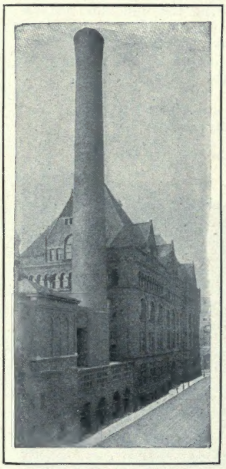

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THE CASCADES AS A FEATURE OF THE WORLD'S FAIR AT ST. LOUIS.

Characteristic view showing part of the details of construction.

The
Technical World

Volume I JUNE, 1904 No. 4

The Development of the Modern Battleship

A Review of Progress in Naval Construction during the Past Forty Years

No. II.—Armor and Ordnance

By WALTER S. LELAND, S. B.

Instructor in Naval Architecture, Massachusetts Institute of Technology

THE DEVELOPMENT of armor and ordnance affords, at this time, a topic quite as interesting as the evolution of the battleship, and its progress has been quite as rapid. From its introduction on the *Warrior* in 1859, until the introduction of face-hardened armor in 1882, the guns and ammunition had a decided advantage over the armor; but since that time the development of armor has been much more rapid, passing through the stages of "composite" and "Harveyed," until finally the modern Krupp armor for a time bade defiance to our strongest guns.

The Earliest Type of Armor-Plate

The first armor consisted of simple wrought iron four inches thick. Then, a little later, "laminated" armor, consisting of sheets of iron plate bolted together, was tried. This, however, was soon found to be inferior to the "solid" armor, four inches of the latter being equivalent to six inches of the former. Attention, accordingly, was at once devoted to the production of solid plates of greater thickness, with the result, at an early date, that iron could be rolled having a thickness of as much as 17 inches, with satisfactory results.

It is a well-known fact that a heavy blow upon an iron plate will cause a sharp indentation, owing to the fact that the force of the blow is concentrated at a single point. If a shot be directed against an armor plate, it will first tear open the surface of the plate, bending the adjacent portions aside; then, pushing the metal on ahead, if projected with sufficient force, it will cause a bulge upon the back side of the plate. This portion of the plate is liable to crack off. If, however, the pressure due to the shot can be distributed over any considerable area of the ship's side, the result will be less disastrous.

It was soon discovered that wood backing offered an ideal cushion for absorbing and distributing the force of impact of a projectile.

The blow against the plate no longer became concentrated, but was distributed by means of the backing over a considerable portion of the side and framing of the ship. As a result, the armor was not so badly dented, and the framing of the ship was less liable to injury.

Many of the illustrations for this article supplied by courtesy of the *Scientific American* and *Collier's Weekly*.

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U. S. S. *WISCONSIN.*

First-class battleship. To this class belong also the *Alabama* and the *Illinois.*

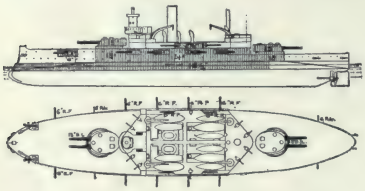
Displacement, 11,653 tons. Speed, 17.2 knots. Bunker capacity, 1,310 tons. Armor—Belt, 16½ in. to 4 in.; turrets, 14 in.; barbettes, 15 in.; deck, flat 2¾ in., slopes 3 in. to 4 in. Batteries—4 13-in. B. L., 14 6-in. R. F., 16 6-pounders, 6 1-pounders, 4 Colts, 2 3-in. field guns. Torpedo Tubes, 4. Complement, 590.

Sandwich Armor

Later on, what is known as "sandwich" armor—consisting of alternate layers of iron and wood—was introduced, and for some years this type of armor was extensively used.

Composite Armor

In 1882, however—the year of the launching of the British ship *Colling-*



Armor and Gun Plans of the "Alabama," "Wisconsin," and "Illinois."

wood—all the early forms were superseded by the introduction of "composite" armor.

Composite armor consisted of a wrought-iron plate with a steel face. The iron was heated to a red heat, and molten steel poured over it, thus effecting a perfect weld. The resulting plate combined the ductility and toughness of wrought iron with the hardness of steel. There was much anxiety at first lest the steel should crack off; but it was soon found, not only that the composite process was successful, but that the armor thus made was superior to any that had up to that time been produced. Not long thereafter, plates of solid steel were produced by French manufacturers; but it was generally found that the composite armor offered a greater resistance to penetration, its face being much harder than was possible where solid steel was used.

Nickel Steel Plates

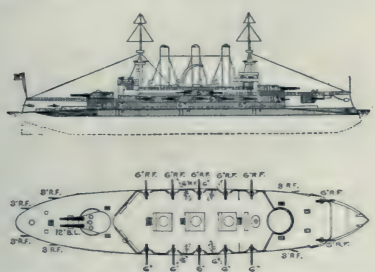
In spite, however, of its evident advantages, some difficulty was experienced with composite armor, owing to the tendency of pieces of the steel face to crack off when the plate was struck by a projectile. This naturally led to efforts to produce an all-steel armor-plate that should be both tough and hard. This was, in a measure, accomplished in 1889 by the introduction of a small amount of nickel into the steel.

The armor originally ordered for our first armored vessels, the *Maine* and the *Texas,* was to be of the composite type; but tests undertaken at the Annapolis Proving Grounds in 1890 demonstrated

beyond a doubt the superiority of the nickel-steel armor, and the original order was consequently changed.

The Harvey Process

About this time, Mr. H. A. Harvey, president of the Harvey Steel Com-



ARMOR, GUN, AND MAIN DECK PLANS OF THE FIRST-CLASS BATTLESHIPS "MAINE," "MISSOURI," AND "OHIO."

pany of Newark, N. J., conceived the idea of producing a solid-steel, face-hardened armor. The outer face of the Harvey armor was hardened by a patented process, while the back side of the plate, being untreated, retained its original softness. Mr. Harvey succeeded in interesting the Navy Department; and in 1891 a sample plate was made under his direction and was tested at the Annapolis Proving Grounds. The results were so remarkable that more extensive tests were made later in the same

11½-INCH KRUPP PLATE AFTER ATTACK BY THREE 12-INCH ARMOR-PIERCING HIGH-EXPLOSIVE PROJECTILES. PLATE AND BACKING COMPLETELY WRECKED.

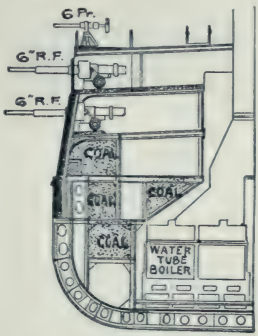
year; and finally, in July, 1892, the Navy Department formally adopted the Harveyed plates for armor protection.

Krupp Armor

Improvements in the manufacture and tempering of these plates took place from time to time, but the Harvey process

12-INCH KRUPP PLATE REPRESENTING ARMOR FOR THE U. S. S. "MISSOURI," AFTER ATTACK BY 3 12-INCH SHELLS. PROJECTILES SMASHED ON PLATE. PENETRATION, 4⅜ INCHES, 4¼ INCHES, AND 3½ INCHES.

was recognized by all navies of the world, until Herr Krupp, the great gunmaker of Essen, Germany, introduced an improved process which made a plate not only of greater resistance but of far greater toughness than had hitherto been

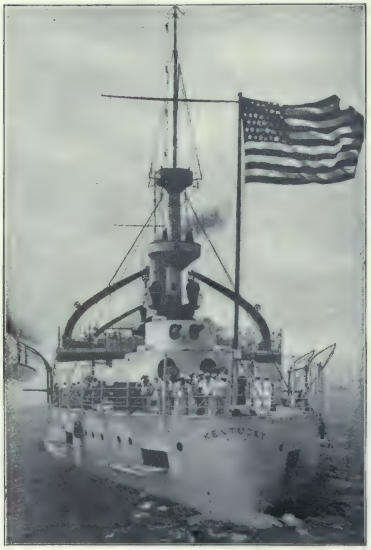


MIDSHIP SECTION OF "MAINE," "MISSOURI," AND "OHIO," SHOWING PROTECTION OF BOILERS BY DOUBLE BOTTOM, SIDE ARMOR, AND COAL BUNKER.

attained. This is especially true of the heavier Krupp armor, it being still a question whether or not the 5-inch Krupp plates are any better than those made by the Harvey process.

Armor manufacturers in the United States promptly acquired from the

Krupps the American rights of manufacture; and in July, 1898, submitted to the Navy Department the first Krupp plate for actual test. It was at once adopted. The Battleships *Wisconsin, Alabama* and *Illinois* were then so nearly completed that the new armor could not be used on them; but the *Maine,* the *Missouri,* and the *Ohio,* begun in 1899, were



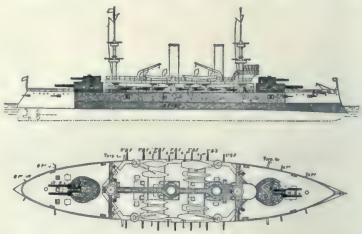
U. S. S. "Kentucky."

First-class battleship. Sister ship, *Kearsarge.* Displacement, 11,540 tons. Speed, 16.9 knots. Bunker capacity, 1,591 tons. Armor: Belt, 16-½ in. to 4 in.; turrets, 15 in. to 17 in.; barbettes, 15 in.; deck: flat, 2¾-in.; slopes 3 to 5 in. Batteries: 4 13-in. B. L., 4 8-in. B. L., 14 5-in. R. F., 20 6-pounders, 8 1-pounders, 4 Colts, 2 3-in. field guns. Torpedo tubes, 4. Complement, 589.

provided with armor made by the new process. It will be interesting to note that the 12-inch Krupp armor on the *Missouri* is considered to be equal in defensive power to the 16½-inch Harvey armor on the *Wisconsin.*

The Rifled Gun

If one is impressed with the rapid development of armor, what must he think of the tremendous strides that have taken place in the progress of making guns and projectiles. The year 1860 had hardly arrived before the manufacture of smooth-bore guns on the continent of Europe had entirely ceased; but it was not until 1865 that England received her first rifled cannon from the Woolwich Arsenal. These guns consisted of an oil-tempered, rifled cylinder, around which



Armor and Gun Plans of the "Kentucky" and the "Kearsarge."

were shrunk a number of wrought-iron coils which had previously been welded together. As soon as the Civil War closed, the United States began converting its old smooth-bore, cast-iron guns into rifles, by reboring them and inserting a rifled tube which was expanded to fit the bore.

In 1871, France introduced an important improvement which consisted in *chambering* or enlarging the bore where the firing charge was placed.

Longitudinal Section through Barbette and Superposed Turret of U. S. S. "Kentucky."

The Breech Loader

It was not until the latter part of the seventies that *breech-loading* was proved to be a success, and it required some time to demonstrate its value. We find, however, guns of the breech-loading type, made by the Krupp Works at Essen, in extensive use in 1880. The first built-up steel gun made in the United States was

designed in 1878; but at that time, proper forgings could not be obtained in this country, and it was about three years later when the gun was finally completed.

Rapid as was the improvement in details of gun mechanism, still more rapid was the increase in size and power. In 1861 the *Warrior* was armed with

SECTION OF 12-INCH COAST-DEFENSE GUN, SHOWING METHOD OF CONSTRUCTION.

In 1883 the Midvale Steel Company of Philadelphia, Pa., was able to provide forgings for 6-inch cannon, and the vessels then building for our "New Navy" were equipped with modern guns.

There have been many recent improvements in guns, mostly in the direction of

10-INCH HARVEY PLATE AFTER COMPLETE PENETRATION BY 6-INCH JOHNSON CAPPED SOLID SHOT. STRIKING VELOCITY, 2,502 FOOT-SECONDS; STRIKING ENERGY, 4,595 FOOT-TONS.

increased power and greater rapidity of fire; but the type of gun has changed but little in the United States, although the *wire-wound* gun has been largely used abroad. This gun, instead of having several steel tubes shrunk together, is wound with wire over the portion subjected to the greatest pressure; and a steel tube, shrunk on over this, gives it practically the same appearance as that of the all-steel gun.

smooth-bore, cast-iron guns, firing a projectile that weighed 68 pounds. Twenty years later the Italian navy possessed 8 Armstrong guns of 18 inches' bore, firing a projectile of 2,000 lbs.' weight and using a powder charge of 376 pounds.

Evolution of the Projectile

Projectiles varied but little, except in size, until the introduction of rifling in the sixties. The round shot then gave way to the pointed, cylindrical shell; but these were still made of chilled cast iron. About 1880, tempered forged steel superseded the cast iron, the latter being too brittle to penetrate the steel-faced composite armor of that date. The tempered steel projectile needed but to be driven with sufficient power, and it would

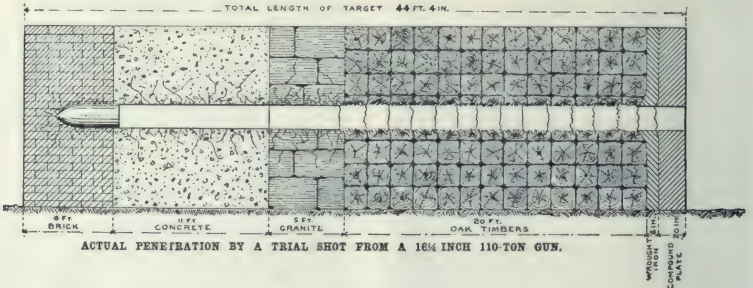
6-INCH JOHNSON SOLID SHOT, BEFORE AND AFTER PENETRATING RE-FORGED HARVEY 10-INCH PLATE.

penetrate any armor then made. The built-up, steel-forged, rifled guns then coming into general use were strong enough to resist the explosion of heavier charges than were previously safe; and the new "brown" powder, just being in-

troduced, was capable of developing the necessary power.

Armor-Piercing Shells

The development of higher-powered guns, and the introduction of Harveyed armor in 1890, necessitated still another development in the projectile. It was necessary to have a shell that could pierce the heavy armor, and one also that could pierce the lighter armor without exploding. The first armor-piercing shells used by the United States Government were procured abroad; but in May, 1890, the Carpenter Steel Company of Reading, Pa., signed a contract with the Navy Department to furnish armor-piercing shells. Other concerns soon followed; and in a few years, shells were produced in this country which were superior to



ACTUAL PENETRATION BY A TRIAL SHOT FROM A 16¼ INCH 110-TON GUN.

any that could be obtained abroad. For many years the Navy Department required that armor-piercing shells should be capable of penetrating a thickness of face-hardened armor equal to the diameter of the shell, without breaking; and that the common shells, carrying a large explosive charge, should pass through half their diameter of armor. Samples of these shells were tested at the various Proving Grounds.

The Johnson Cap

No marked improvement was made in projectiles except as above noted, until 1897, when the "Johnson cap" was introduced. The Johnson cap is a piece of soft steel securely fastened to the point of the projectile; and its use increases the efficiency of the armor-piercing shell by from fifteen to twenty per cent. It had frequently been observed that a piece of soft metal, placed directly in front of a face-hardened armor-plate, enabled a projectile to penetrate more easily; and the invention of this cap was the direct outcome of these observations.

About three years ago a projectile was developed that could carry a heavy bursting charge through a thickness of armor equal to its own diameter before exploding. This is probably the best shell that has been produced to date, either in this country or abroad.

Black, Brown, and Smokeless Powders

Black powder, the oldest of our explosives, originated in the Far East in the seventh century, and was used by the Chinese in making fire-crackers. Traders carried the secret of its manufacture abroad. In 1234 it was used in China, in the cannon of an invading army; and thus the Chinese learned of its military value.

Black powder is a mixture of 75 parts of saltpeter, 15 of charcoal, and 10 of sulphur. Powder, though made of the same materials and mixed in exactly the same proportions, may vary greatly in its rate of burning, depending upon its density, hardness, size, and shape of grain. These facts have been known for many years, and have been practically applied in adapting black powder to various uses within the range of its possibilities. For military and naval operations, its use is extremely limited at the present time.

About 1883 a modification in the manufacture of gunpowder was made in Germany, and the "brown" powder was produced. This consisted of 79 parts of saltpeter, 18 of charcoal, and 3 of sulphur. The charcoal used was made from straw, and gave the product its peculiar chocolate color. The powder was pressed into

cubes or hexagonal prisms, and had the power to produce high velocities with comparatively low pressures, making it especially useful in high-powered guns. Brown powder is a comparatively slow-burning powder, and requires a priming charge of fine-grained black powder to set it off properly. About 57 per cent of the products of combustion are given off as smoke and residue, which foul the gun badly and make it impossible for the gun crew to see. This powder, however, was a great step in advance of the black powder, and without it the high velocities of the rifled guns could not have been obtained. This powder cost 30 cents a pound, and the charge was half the weight of the projectile. For a 13-inch gun firing a shell of 1,100 lbs.' weight, the powder charge would be 550 lbs.

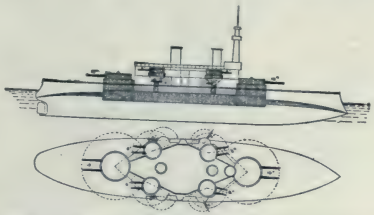
The first vessel in our Navy to be supplied with the modern "smokeless" powder was the *Marblehead,* in October, 1897, since which date other vessels have been supplied as opportunity offered. Smokeless powder has been used in foreign navies to some extent for the last ten or twelve years, with some success; but a really satisfactory smokeless powder is of very recent date.

If common cotton is dipped in a mixture of nitric acid and sulphuric acid, and then washed and dried, it preserves its original form, but becomes a highly explosive substance known as "gun-cotton." This gun-cotton is dissolved in a mixture of ether and alcohol; and then, after thickening into a solid mass, becomes the basis of our smokeless powder.

The process of manufacture of all navy smokeless powders is essentially the same; but the size of grain differs for each caliber and can be used with safety for that caliber only. If the grains of powder be too small, the explosion will be too rapid and the pressure in the gun too high. If, on the other hand, the grains be too large, the powder will burn

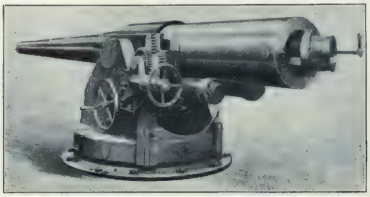
U. S. S. *OREGON.*

The "Bull-Dog" of the American Navy. Photo taken in 1898 just before the ship sailed on her memorable trip around the Horn to join Admiral Sampson's fleet in Cuban waters. To the same class belong the *Indiana* and the *Massachusetts.*



ARMOR AND GUN PLANS OF "INDIANA," "MASSACHUSETTS," AND "OREGON."

too slowly, and the maximum pressure is likely to be reached when the projectile is near the muzzle of the gun. The barrel is here thinner than at the breech, and



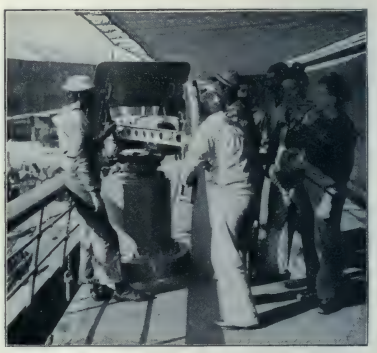
6-INCH NAVAL RAPID-FIRE GUN, WITH FLETCHER BREECH MECHANISM.

Weight of Gun, 6 tons; Weight of Shell, 100 lbs.; Weight of Charge, 47 lbs.; Muzzle Velocity, 2,150 ft. per second; Muzzle Penetration, 15.4 in. Iron; Number of Aimed Shots per Minute, 6.

the result is that the muzzle may be blown off. This powder requires a smaller charge than the brown powder, and at the same time gives the shell about 30 per cent greater velocity and nearly double the striking energy.

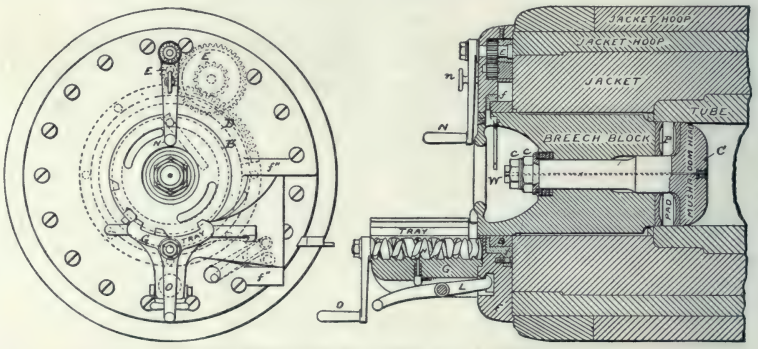
"Powder" as applied to the modern naval explosive is a decided misnomer, for the "grains" in no way resemble a powder. The brown variety, as before stated, was usually pressed in the form of cubes or prisms, the cubes varying from the size of a bean in the smaller guns to blocks 1½ inches on a side in the largest ones. The United States Navy used an hexagonal prismatic form about four inches long, the size varying with the caliber of the gun. Smokeless powder generally comes in the form of either flat strips, long sticks, or shorter cylinders.

Some few years ago all ammunition for the guns was loaded in metallic cartridges. This made an extra weight, added to the cost, and required more space for storage in the ship's magazine. The larger ammunition was in this way



SIGHTING RAPID-FIRE GUN ON CRUISER "BUFFALO."

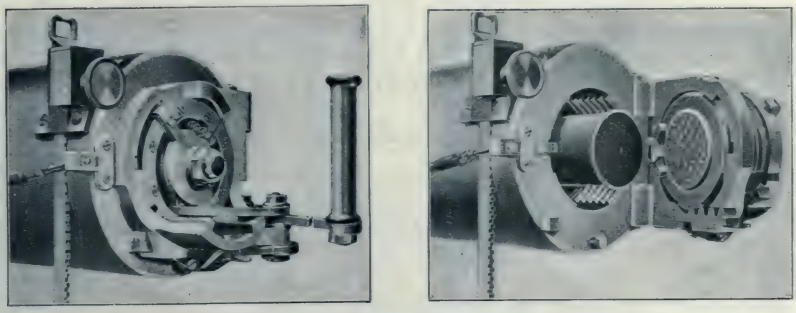
rendered too heavy for handling; and it is generally conceded that better and quicker work can be done by using the powder in bags which can be properly



BREECH MECHANISM OF 12-INCH COAST-DEFENSE GUN.

packed behind the shell after the charge has been inserted in the gun. The English have adopted this practice for nearly all guns of over 5 inches' diameter.

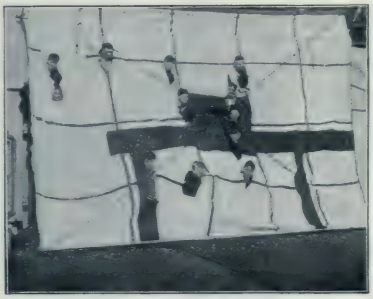
The tremendous development in the offensive powers of our modern ships and guns is not due alone to improvements in



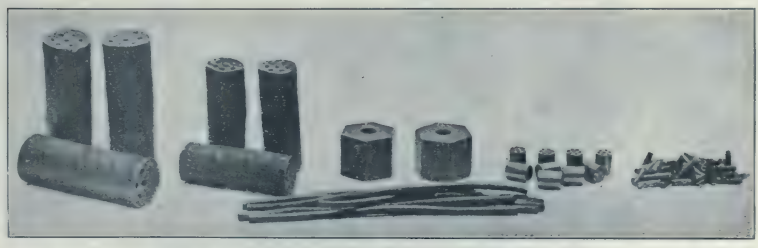
A DASHIELL BREECH MECHANISM B

A—Closed. Breech Rotated by Partial Stroke of Lever. B—Open. Empty Cartridge Case Started Out by Extractor.

guns or powder or projectiles, but to the simultaneous and progressive development of all three. Little more than forty years ago the heaviest gun known was the 68-pounder. This gun was about 9 inches' bore, and fired a 68-pound projectile with a 16-pound powder charge, but was powerless against 4½ inches of wrought iron. To-day our vessels are equipped with 12-inch guns, which, with a charge of 400 lbs. of smokeless powder, are capable of driving an 850-lb. projectile through 51 inches of solid wrought iron. It took nearly four minutes to load and fire one of those old guns, while the new 12-inch guns can be loaded and fired in about 50 seconds with perfect safety. If a projectile from one of the old 68-pounders hit its mark, it was due to good luck rather than to good management; but the modern 12-inch gun has scored seven hits in less than six minutes at target practice, and the 6-inch gun has a record of nine shots and nine hits in one minute.



World's Record Target of U. S. S. "Kearsarge." The Firing was done by an 8-in. Gun; Range, 1,600 yds.; Speed of Battleship, 10 Knots an Hour.



Dupont Smokeless. (12-in. guns) | Dupont Smokeless. (10-in. guns) | Brown Prismatic. (not smokeless) Cordike (Smokeless). (for 4.7-in. guns) | Peyton Smokeless. (6-pdrs.) | Laflin & Rand Smokeless. (3.2-in. guns, siege guns, and howitzers)

VARIOUS FORMS OF SMOKELESS AND BROWN POWDERS.

Electricity at the Louisiana Purchase Exposition

The Exhibits in the Palace of Electricity

The Second of a Series of Articles Describing the Noteworthy Electrical Features of the Universal Exposition at St. Louis

By CALE GOUGH, Department of Electricity

OCCUPYING A CENTRAL POSITION in the group of magnificent buildings at the Louisiana Purchase Exposition is a structure whose exhibits probably produce on the average visitor a more lasting impression than do the displays of any of the other neighboring structures. This building is the Palace of Electricity.

That which distinguishes and separates the exhibits of the Palace of Electricity from those of the surrounding buildings, is the fact that these exhibits represent deep and concentrated thought rather than craft of hand. The ponderous engines in Machinery Hall are admirable for their size; the delicate laces and intricate carvings in the Japanese exhibits portray both skill and patience; but the operation of the wireless telegraph system, the Röntgen ray machine, or the automatic telephone exchange impress the observer with the fact that the brain predominated in the combination of thought and mechanical skill necessary to produce the perfect working apparatus before him.

There is hardly an important application of electricity—however recently conceived—that does not form part of the display in the Palace of Electricity. The exhibits represent the very crest of the wave of advancement; in fact the building may be said to be ahead of the times, as there are several conceptions now being put into practical form that will be exhibited when perfected.

The exhibits are divided into five groups, the features of each exhibit being similar to those of the others in the same

GENERAL VIEW LOOKING NORTH FROM FESTIVAL HALL.

group, either in the use of the generated electricity or in the method of production. As far as possible, each group has been given space to itself in one portion of the building. The foreign exhibits, however, have been kept intact. These in several instances contain apparatus be-

The prominent part in the industry occupied by electric transportation problems is shown in the array of railway motors, controllers, and, in fact, complete equipments mounted on trucks. The most advanced types of controllers, as well as some of the older types, are to be

VIEW LOOKING NORTHEAST FROM FESTIVAL HALL.
Showing the Education and the Mines and Metallurgy Buildings.

longing to all of the classes, and thus to some extent the scheme of classification has not been strictly adhered to.

Generators and Motors

In the group entitled "Machines for Generating and Using Electricity," there are shown all of the practical forms of dynamos, motors, transformers, frequency changers, etc. The generators range in size from the minute gas-engine igniter to one of the direct-connected type of 400-K. W. capacity. The display of motors in their varied application to machinery, is interesting. Several of the spaces represent modern machine shops. Although filled with drill presses, shapers, lathes, and similar tools, not a belt is to be seen. A little motor at the base of the machine, or probably perched at the very top, removes all necessity for belts. One exhibit that shows well the application of motors in driving machinery is that of a motor-driven planer. The motor is direct-connected, and it is necessary to reverse it every time the bed of the planer is returned for another cut. This is done automatically. When the bed reaches the end of its stroke a trip is thrown. This opens the circuit, reverses the motor, and then gradually cuts out the starting resistance.

seen. Systems of multiple-unit control, whereby a motorman on the forward car of a train is able to control all the motors on the cars behind him, are shown in operation.

Of special interest, because of its recent introduction, is the alternating-

INSTALLING POWER GENERATOR FOR CASCADES. FORCES 90,000 GALLONS OF WATER A MINUTE THROUGH FOUNTAINS INTO GRAND BASIN.

current railway motor and the system of controlling it. The controlling apparatus differs from that of the direct-current motor where starting resistance is used. Transformers with rather complicated connections take the place of the resist-

THE PALACE OF ELECTRICITY AT NIGHT.

ance. An exhibit of a complete equipment of transformers, motors, and all apparatus required in the operation of a car driven by alternating current, shows the workings of the system in a very satisfactory manner.

Another phase of electric railway practice takes a prominent part in several ex-

A GROUP OF IGORROTES.

Typical Specimens of one of the Most Barbarous of the Tribes Included Among Our New Subjects in the Philippine Archipelago.

hibits. This is the application of electricity in compressing air for operating the brakes. There are exhibited several styles of combined air compressors and motors, together with their governors for automatically cutting the motor in and out of circuit whenever the pressure of the air falls below or exceeds certain set limits. One exhibit is that of a complete air-brake equipment including air cylinder, brake levers, reservoirs, compressors, etc., mounted on a suitable frame so that the performance of the whole system can be readily observed.

Batteries

The display of batteries, both primary and secondary, is included in the "Electro-Chemistry" group. Secondary batteries, ranging in size from that designed for automobile service to the large cells adapted for central-station work are shown. Two cells exhibited have a capacity of more than 3,000 amperes.

The Edison iron-nickel battery, which is quite a remarkable departure from the lead-element cell, and which a few years ago excited so much comment in the press, forms a part of Mr. Edison's exhibit.

A rather remarkable primary cell is a dry battery of unusual dimensions, which is capable of giving more than a thousand amperes.

Of late, considerable attention has been given the purification of water in large quantities for use in steam boilers. Heretofore this has been accomplished by the use of chemicals which precipitated or transformed the harmful ingredients. It has been discovered, however, that by means of electricity the water can be purified at much less cost. The process consists in sending current through the water, the electrodes introducing the current being made of a peculiar metallic composition. The impurities of the water

are precipitated. A complete plant for purifying water by electricity is installed in the court of the building. As a proof of the efficacy of the process, a public drinking fountain is maintained, where the purified water is at the disposal of visitors.

Wireless Telephony and Telegraphy

Probably the most interesting of all exhibits, and those which impress the visitor more forcibly than any others, are the demonstrations of wireless telephony and telegraphy.

Several systems of the former are installed within the building. A station of one of the exhibiting companies consists of three towers extending to a height of seventy-five feet. From these is supported the antenna, or collecting mesh, the wires of which converge to enter the sending apparatus in the center of the space between the towers.

One of the exhibits of wireless telephony consists of two stations in opposite sections of the building. Between these, conversations are carried on.

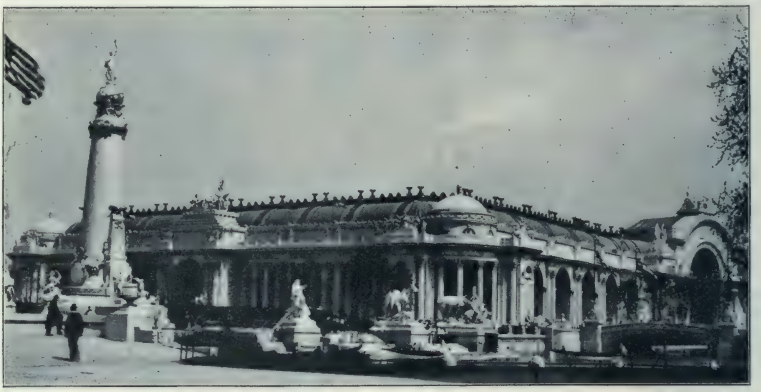
The most interesting of all the wireless telephone exhibits is that installed in the court of the building. The visitor is supplied with a telephone receiver free from connecting wires. He wanders at will to any part of the court. Before placing the receiver to his ear, no noises are audible other than the constant hum of the machinery within the building. But upon placing the receiver to his ear, he may hear music, the voice of his friend, or whatever other sounds may be given to the instrument within the building. This demonstration arouses new speculations as to the future possibilities in wireless telephony.

THE FERRIS WHEEL.
View taken during Construction, after the recent snowstorm.

Working exhibits of the customary mode of telegraphy are those of the cen-

EDUCATIONAL BUILDING, WITH PALACE OF ELECTRICITY IN BACKGROUND.

tral offices, for the Exposition, of two telegraph companies. The telephone exchanges of the Exposition, which are likewise installed in the building, demonstrate in the best manner possible the



MANUFACTURES BUILDING.—LOUISIANA PURCHASE MONUMENT IN THE FOREGROUND.

use of this method of speech transmission.

In addition to the telephone exchanges there are several other working telephone exhibits. The automatic exchanges are specially worthy of attention. An in-

ILLUMINATION AT NIGHT.
View Showing Corner of Palace of Electricity, Towers of Machinery Building, and Lagoon Bridge.

spection of one of these complicated assemblages of magnets, cams, and levers arouses a profound respect for those who had the patience and ingenuity to construct it.

How Incandescent Lamps are Made

One of the most instructive features of the Palace of Electricity is the model incandescent lamp factory, where can be observed all the processes in the manufacture of the lamp from the making of the filament to the sealing on of the base. The processes in themselves are very interesting, but the fact that the visitor is so familiar with the product makes the plant doubly so.

Electro-therapeutics

The discovery of the Röntgen and Finsen rays gave a great impetus to electro-therapeutics. The manufacturers kept apace with the demands of the physicians; and at the present time, apparatus for the production and application of these curative rays may be had in great variety. These are all exhibited in a section of the building devoted exclusively to electro-therapeutics. Static machines, induction coils, and batteries predominate here; but, in addition, there are many other forms of electrical apparatus for the treatment of disease, such as vibrators, massaging devices, arc-light cabinets, etc.

In the southern portion of the building is another exhibit that probably belongs in the electro-therapeutic class. This is the exhibit of the "Acousticon" and "Massacon," the former instrument being used as an artificial means of hearing. The massacon is an apparatus for massaging the middle ear, and restoring it to normal condition when diseased.

VARIED INDUSTRIES BUILDING IN FOREGROUND.—TRANSPORTATION BUILDING IN REAR.

The Foreign Exhibits

The space devoted to foreign exhibits is quite considerable. The exhibit of Germany is largely composed of electrochemical apparatus. Telegraph instruments and cables predominate in the French section. One of the cable companies exhibits a piece of a twisted and torn cable found in the sea off the Island of Martinique after the eruption of Mount Pelée. Quite a large portion of the English exhibit is devoted to the display of electrical measuring instruments. A 150,000-volt transformer is a feature of the Japanese section. The space devoted to Italy contains many measuring instruments worthy of attention, one of these being a recording wattmeter of ingenious construction.

Edison Historical Exhibit

In marked contrast with the modern machinery around it is the historical exhibit of the Association of Edison Illuminating Companies. Here are exhibited the original Edison dynamos used in the first central station. The famous Jumbo generator is also near by. The first application of electricity to traction, is shown by the original car.

A feeling of profound reverence is aroused when the observer remembers that these crude machines were the beginnings of all that he sees around him.

The immense amount of labor necessary in bringing together such a varied collection of all that is interesting in the electrical industry, can hardly be appreciated by one who has not been intimately connected with the work. The collection and installation has, however, been finished in an admirable manner; and Prof. W. E. Goldsborough, as Chief of the Department of Electricity, may rightly feel satisfied with the work of the past two years.

A GROUP OF AINUS.
A Hairy Race of Short Stature, inhabiting the Northerly Islands of Japan.

Mechanical Refrigeration

A Brief History of Early Attempts, Followed with a Detailed Description of the More Efficient Modern Absorption and Compression Systems Used in Cold Storage and Packing Houses

By OSWALD GUETH, M. E.
Technical Editor, *Cold Storage*

THE early attempts at artificial refrigeration date back to a period over 300 years ago, when it was first discovered that artificial cold could be produced by the physical action which takes place when certain salts are dissolved, most commonly in contact with ice or snow. In order to dissolve the salts, heat must be furnished; and this heat is taken out of the mixture, whose temperature is consequently lowered.

This process, however old, is still in every-day use in the laboratory and in ice-cream freezers for domestic purposes.

The Cold-Air Machine

Until about thirteen years ago the cold-air machine embodied the most successful method of producing low temperatures by purely mechanical means. This machine is based on the utilization of the reduction of temperature that takes place when compressed air expands while doing work in an air engine. The air is compressed by a compressor, and the heat generated by compression is withdrawn by cooling water.

The Vacuum Process

The earliest refrigerating machine worked on what is known as the "vacuum" process. Here, water is used instead of air, but the machine in its simplest form works on the same principle as the cold-air machine. The vacuum is formed by a vacuum pump which withdraws the vapor from the refrigerator and compresses it into a condenser. The refrigeration produced by the evaporation of a part of the water, causes a corresponding portion of the water to turn into ice. Owing, however, to the high vapor tension of water, a perfect vacuum was necessary to secure an intense refrigeration; and this led to the introduction of sulphuric acid as an absorbing agent for the water in the vapor. A machine of this construction works on nearly the same principle as an absorption machine, which we shall describe later on. The necessity of renewing the sulphuric acid from time to time represents one of the principal expenses involved in the use of this type of machine, and has probably prevented its more universal adoption.

The modern refrigerating machine is based on the "absorption," and to a greater extent on the "compression," system. The process of producing the cold consists in evaporating liquids that have low boiling points. The latent heat of vaporization represents the amount of cold that can be produced in this way.

These two systems have made mechanical refrigeration what it is to-day—one of the leading industries; and this becomes apparent, when we see that ice plants are being erected every day, and that cold-storage houses can be found all over the world, wherever civilization has made its entrance.

In leading up to an intelligent understanding of the absorption and compression systems, let us first briefly examine how the cold is artificially produced.

How the Cold is Produced

As an illustration, let us take an atomizer, which may be charged as usual with perfume, or, still better, with ether.

By compressing the rubber bulb a fine spray of the volatile liquid is thrown

upon the flesh of the hand, where the liquid rapidly evaporates, causing a sensation of cold. By continuing this process, we are able to produce a temperature sufficiently low to freeze the flesh. The atomizer, therefore, is a little refrigerating machine, and is actually used as such in laboratories for freezing small specimens. Its principle differs in no respect from that of an ice machine capable of producing 100 tons of ice a day.

How is the cold produced? Cold is simply the absence of heat. We know that all liquids tend to evaporate, and that if evaporation is sufficiently rapid, the liquid boils. Each liquid has its own boiling point. Water, for example, boils at 212° F.; ether at 100° F. We also know that the boiling point varies with the pressure upon the liquid; that is, the higher the pressure, the higher will be the boiling point, and *vice versa*.

In order to boil a liquid, we must add heat to it, and this heat must be furnished from the nearest object. In the case of the atomizer, it is taken from the flesh of the hand. A still better illustration may be had by dipping the hand in water and then waving it in the air. The evaporation of the water causes a sensation of cold in the hand, which will be still more distinctly felt if alcohol be taken instead of water, as alcohol evaporates at a lower temperature.

In modern refrigeration, we must have a liquid with a low boiling point and a high latent heat of evaporation. There are quite a few liquids at present in use, such as ether, sulphur dioxide, carbonic acid, ammonia, etc. The liquid that is most in use for its many advantages, is anhydrous ammonia.

Later, we shall refer at greater length to the properties of this last-named liquid; but for the present shall merely mention the fact that liquid ammonia boils at 30° below zero. It is shipped in heavy wrought-iron cylinders, under a pressure of 120 to 150 lbs. per square inch.

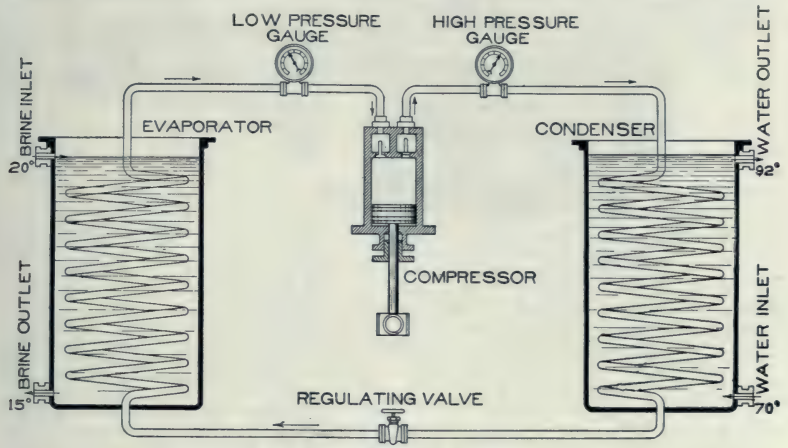


FIG. 1. COMPRESSION SYSTEM.

Compression and Absorption Systems

We are now ready to understand the principle of a refrigerating plant.

The apparatus consists of a liquid receiver, into which the liquid is charged from the drums; and an expansion coil. The ammonia in the receiver is at the temperature of the atmosphere and under an average pressure of 150 lbs. per square inch. A small liquid line leads from the bottom of the receiver to the expansion coil. The ammonia trickles through the fine opening of the expansion valve, and, being in the large open expansion coil and relieved of pressure, proceeds to boil away violently into ammonia gas. In doing this, it absorbs the necessary heat from the coil, so that, when the coil is submerged in water, the ammonia will continue to boil, and will further take its supply of heat from the sur-

rounding water, until the water has been cooled and is finally frozen.

In practice this method of freezing would meet with difficulties, for the expansion coil must not be open to the atmosphere, as it would thereby waste ammonia of greater value than the ice made; nor can it be closed, lest it fill with gas and stop the process. A powerful air pump, commonly called a "compressor," sucks the gas from the expansion coil, and compresses it into a liquid to be used again. This is illustrated in Fig. 1. The gas does not turn into a liquid in the compressor, but is forced as hot gas under high pressure into the "condenser," which consists of a series of coils surrounded by cold water that removes the heat of compression and reduces the gas to a liquid, ready for a new round of service.

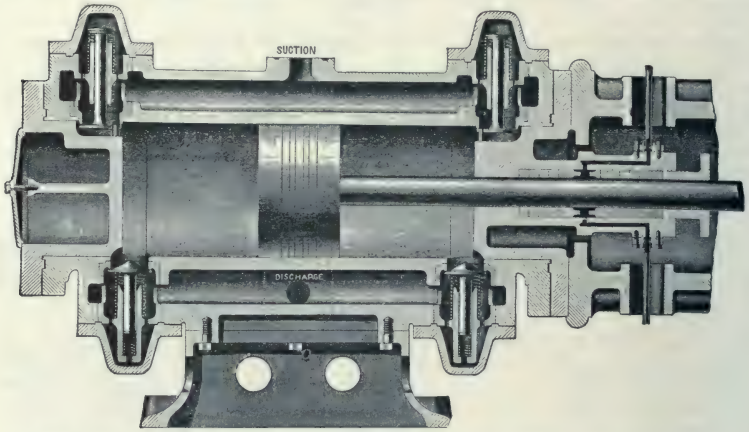


FIG. 2. SECTIONAL VIEW OF DOUBLE-ACTING HORIZONTAL AMMONIA COMPRESSOR.

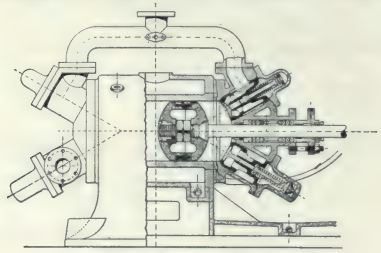


FIG. 3. SECTION OF LINDE COMPRESSOR.

This process is called the "compression" system.

The Absorption System

A second method of operation in extensive use, is that known as the "absorption" system, which is based on the fact that ammonia gas has a great affinity for water. One part (volume) of water at 32° F. will absorb about 1,000 parts of ammonia gas. This fact is utilized in the following general way:

The expanded gas, having performed the work of cooling in the expansion coil, is subjected to a stream of cold water, and is rapidly absorbed, producing *aqua ammonia*, or ammonia liquor. This liquor is pumped into a closed vessel, called a "still," where it is heated up by means of steam coils, and the ammonia driven off as gas. The gas, being confined, produces pressure similar to that of steam in a boiler. It passes from the still to the condenser, where it is cooled and liquefied, the necessary pressure coming from the still. The remainder of the cycle of operation is the same as for the compression system.

By making a comparison, we find that the absorption system is older than the compression system, and that only about 10 per cent of the machines now sold are of the absorption system. It is claimed that this system uses from 2½ to 3 times as much water as compression machines of the same capacity. Tests, it is also alleged, have shown that an absorption machine requires nearly 25 per cent more fuel than one of the other type. These apparent defects of the absorption machine are contradicted by the manufacturers of this type, who claim that their system has been greatly improved within the last few years. By

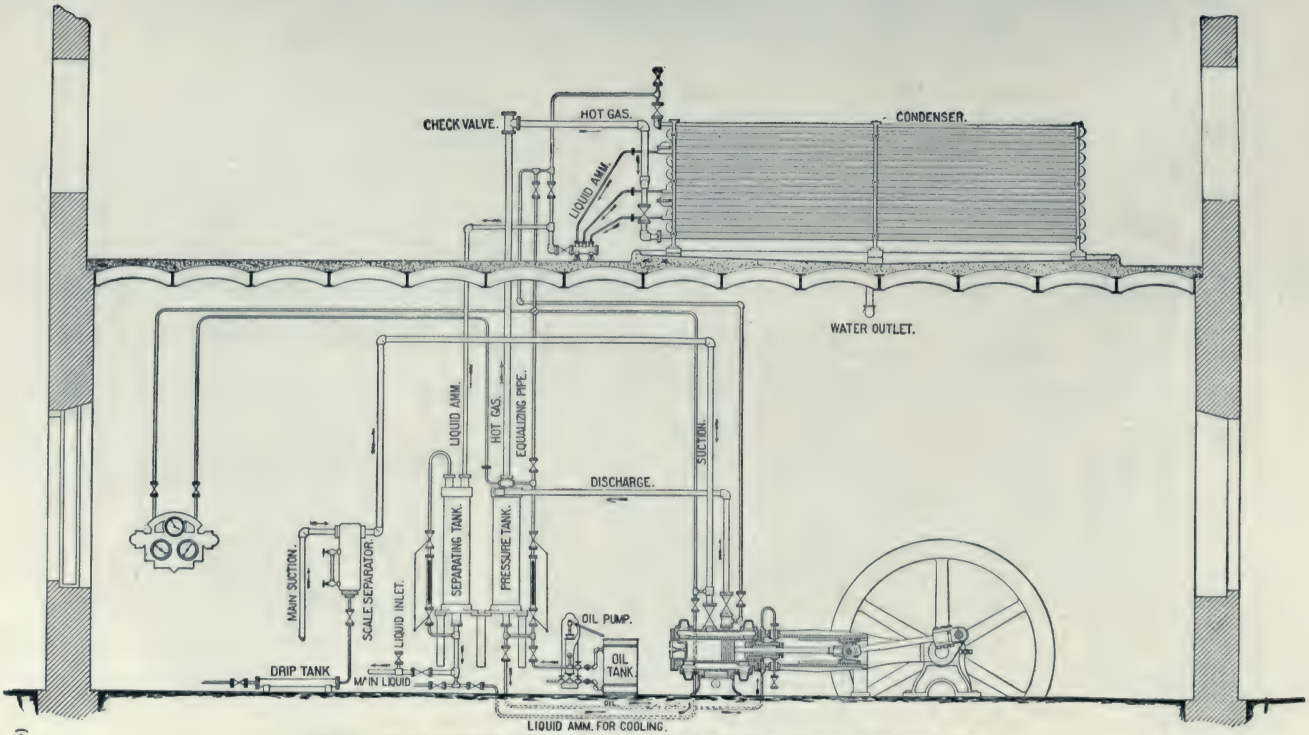


FIG. 4. DE LA VERGNE REFRIGERATING PLANT, WITH HORIZONTAL COMPRESSOR.

using exhaust steam instead of live steam for the liquor still, the coal consumption is greatly reduced; and through the production of perfect anhydrous ammonia, the quantity of cooling water needed is also much diminished.

By taking the compression system as a basis for further observations, we find, as I have mentioned before, that besides ammonia other liquids are used as working fluids in refrigerating machines. They are used on the same plan as ammonia, and the machines are constructed on the same principles as the ammonia compression machines.

In the choice of a circulating medium we should consider, first, that the refrigerating effect depends on the latent heat of vaporization of the medium; and, second, that the size of the compressor depends on the number of cubic feet of vapor which must be taken in to produce a certain amount of refrigeration. Before we go into a detailed description of the complete cycle of operation, it would therefore be wise to study a little the properties of the principal liquids in use to-day—namely, ammonia and carbonic acid.

Ammonia is a combination of nitrogen and hydrogen (NH_3). It is liquefied at 30° below zero at atmospheric pressure, and, of course, at higher temperatures if higher pressures are employed.

Ammonia is not combustible at the ordinary temperature, and a flame is extinguished if plunged into the gas. If, however, ammonia be mixed with oxygen, the mixture may be ignited, and it burns with a pale yellow flame. Ammonia is not explosive; but when in drums containing the liquid ammonia insufficient space is left for the liquid to expand when subjected to higher temperatures, the drums will burst, as has often happened in hot summers. The ammonia vapors are highly irritant, causing suffocation, and this is one of the strongest arguments in favor of carbonic acid. It is claimed that air containing eight per cent of carbonic acid gas can be inhaled without danger, while an atmosphere containing only one-half of one per cent of ammonia is considered decidedly dangerous. On the other hand, a leak in the ammonia system is easily detected on account of the strong smell of the ammonia, while this is not the case with carbonic acid. The fact, however, that carbonic acid gas is entirely uninjurious to victuals and non-corroding on any metal, speaks greatly in its favor. Further, the capacity of the carbonic acid compressor may be very small as compared with that required in the ammonia system, and this makes the former very adaptable for hotels, restaurants, and aboard ship, where space is very valuable. Carbonic acid liquefies at 124° below zero at atmospheric pressure. At 32° it liquefies under a pressure of 36 atmospheres.

Mechanical Details

We shall study now the different apparatus constituting an ammonia compression plant of the present day.

The system comprises three principal parts: (1) The compressor, which sucks the gas from the expansion coil and compresses it into the condenser; (2) the condenser, where the compressed gas is cooled and liquefied; and (3) the expansion coil, where the liquefied gas re-expands and does the refrigerating work.

We shall first look at the design by the originator of the ammonia compression system, the Linde compressor, Figs. 2 and 3. This design is worth careful study by both the student and the engineer, as it is a good example of how efficiency may be combined with simplicity. The compressor is double-acting; that is, gas is discharged at each stroke. The cylinder is made of a plain cylindrical bushing, which will expand and contract equally all over, according to changes in temperature. The suction and discharge valves are placed in the two spherical heads. The compressor piston is turned spherical, to fit exactly into the front and back heads of the compressor, which reduces to a minimum the clearance between piston and heads. The stuffing box is the typical Linde design, which has been generally adopted. It consists of a metallic packing divided by a hollow sleeve. The empty space formed by the sleeve is connected to the suction side of the compressor. Any ammonia, therefore, which might escape through the inside packing, will be drawn back to the compressor, and consequently the other

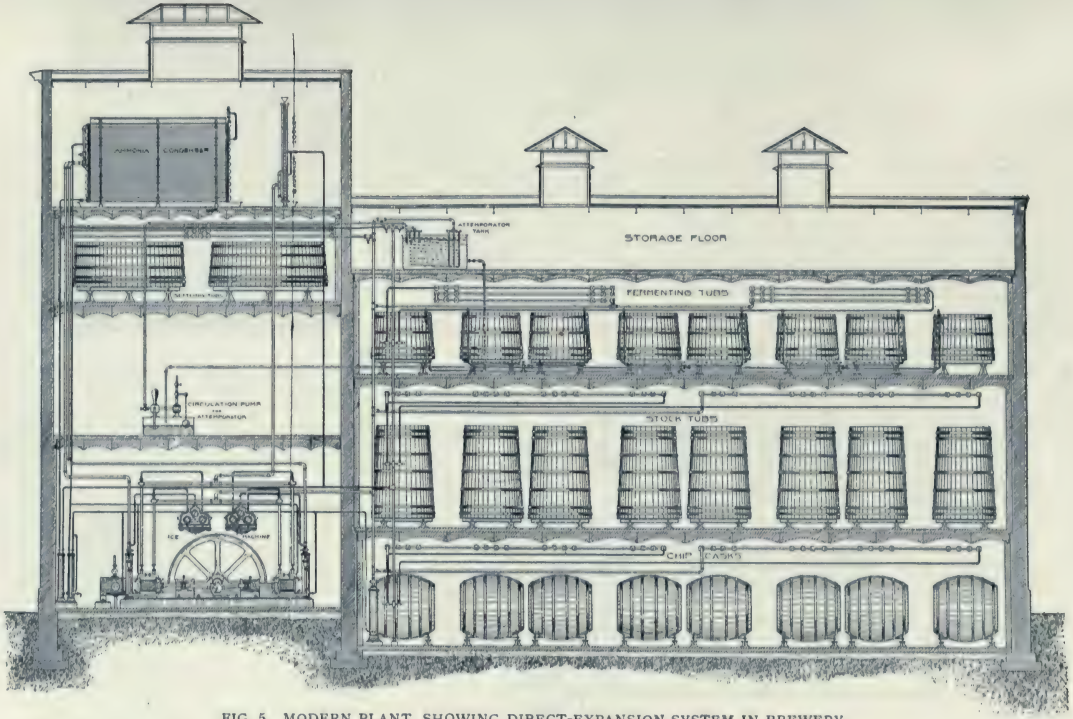


FIG. 5. MODERN PLANT, SHOWING DIRECT-EXPANSION SYSTEM IN BREWERY.

packing is kept under only back pressure. The front gland is hollow and kept free of oil from the trap by means of a small oil pump.

To avoid superheating and to obtain a higher efficiency, the compressor cylinder is surrounded by a water jacket. The cold water enters at the lowest point, and overflows on top. In this way the water keeps the compressor walls cool, and takes care of the greater portion of the compression heat.

FIG. 6. PACKING HOUSE WITH THE BRINE SYSTEM.

In examining the ammonia condenser, we notice two decidedly different kinds: (1) The submerged condenser, generally having coils spirally arranged and immersed in a tank of cold water; (2) the atmospheric condenser, having the coils made of straight length of pipe with return bends, all exposed to the air, with cold water trickling constantly over them.

The compressor and condenser form the "compression side." The ammonia gas is drawn into the compressor through two suction lines, one from the beer cooler, the other from the brine tank, entering through the suction valves in the upper parts of the cylinder heads. It is then compressed and forced out through the discharge valves, which are located at the lowest point of the cylinder. The compressed gas passes into the oil trap, where any lubricating oil that may have been carried from the cylinder is deposited. This oil is drawn from the trap, and continuously circulated through the stuffing box. From the oil trap the vapor goes to the condenser, which it enters at the highest pipe. It leaves the condenser in the form of liquid, from the lowest coil, and is led to the liquid receiver. From here it is fed to the expansion coils, which are not shown in the illustration. An oil separator is so connected that oil may be drawn from either the liquid receiver or the oil trap, and separated from whatever ammonia it may contain, the oil being then drawn out of

FIG. 7. PIPES THAWED OFF. Showing Unclean Walls.

the bottom of the separator, and the ammonia returned to the system.

We come now to the third operation, the "expansion side." The expansion side consists of a series of pipe coils, the inlet of which is connected with the main liquid line, while the outlet is connected with the suction of the compressor.

The coils may be immersed in a tank filled with a strong solution of salt or of chloride of calcium. This brine, after having been cooled considerably below the freezing point of water, may be pumped through coils suspended on the walls or ceilings of the rooms to be cooled, and thence returned to the brine tank. This method is called the "brine" system or "indirect expansion."

In the case of "direct" expansion, the expansion coils may be placed directly in the rooms to be refrigerated, the return pipes for the gas being connected to the compressor. Which of these two systems has the greater advantage, is hard to decide, as this depends on the conditions in each particular case.

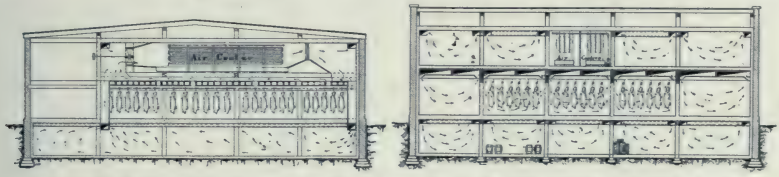


FIG. 8. SIDE AND END VIEWS OF STORAGE HOUSE WITH FORCED-AIR COOLING SYSTEM.

Practical Applications

The various applications of artificial cold have in no instance met with greater success than in breweries, where the introduction of mechanical refrigeration has made it possible to carry on the business even in the warmer latitudes. A brewing plant, using direct expansion, is illustrated in Fig. 5.

The expansion of the ammonia takes place in the pipe coils, which are placed directly in the different rooms to be cooled. The flow of liquid ammonia into the pipes is regulated by expansion valves, which are so adjusted as to maintain the temperature desired. The return pipes from the coils are joined to one main pipe, termed the "stand pipe," with a small trap placed at the lowest point, to prevent any scale from entering the compressor.

In addition to the cooling of the storage cellars, there is another duty to be performed by the refrigerating machine—the cooling of the boiling beerwort, and the cooling of the beer in fermentation. The hot wort, coming from the brew kettle, is partly cooled by the atmosphere to 110°, being exposed in a "coolship," which is generally placed on the roof of the building. From here the wort flows over the Baudelot cooler, through the upper section of which fresh water is used, cooling the wort down to 60°, while in the lower coils the wort receives the final chilling to 40° by direct expansion of ammonia or cold brine. The wort then enters the fermenting tubs, where the heat of fermentation is removed by attemporator coils through which refrigerated brine or fresh water is circulated. The cooling of the brine or water for the attemporators is accomplished by means of direct-expansion coils placed in the attemporator tank. The water is then circulated through the fermenting tubs by means of an automatic pump.

The preservation of goods in cold storage, and particularly in packing houses, has opened another wide field for mechanical refrigeration. By artificial cooling, the temperature of cold-storage and chill rooms can be regulated and maintained to suit requirements. Fig. 6 shows a packing house using the brine system. The ammonia-expansion coils, instead of being placed in the rooms to be cooled, are submerged in an insulated tank containing brine, which, after being cooled, is pumped through pipe coils located in the rooms, taking up heat there, and being then returned to the tank and recooled.

The method of placing the cooling coils on ceilings or walls, as in Fig. 7, has some disadvantages. We know that cold alone is not enough to preserve the goods, as we see that meat kept in poorly ventilated cellars is soft and greasy on the surface, and soon spoils when exposed to the open air. Cold rooms are therefore very useful, if sufficient ventilation is provided to carry off the damp air and replace it by dry air.

Further, the frost that forms on the

coils has from time to time to be removed; otherwise, if the temperature rises, the pipes will commence to drip, thereby keeping the rooms damp and mouldy. We therefore frequently find drip-pans or gutters provided underneath

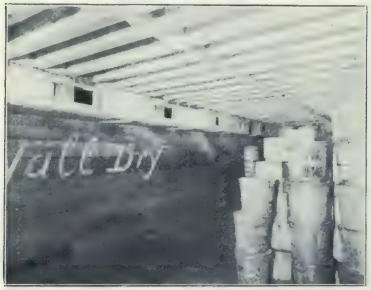


FIG. 9. BUTTER FREEZING ROOM—AIR CIRCULATING SYSTEM.

the coils; or the latter, especially in packing houses, are placed in a cooling chamber overhead, with a proper construction and arrangement of air-ducts to insure ventilation and the circulation of the cold air.

These apparent disadvantages have led to the construction of a new air-cooling system, which, on account of its many advantages, has been generally adopted in European abattoirs. The cooling pipes in this system, Fig. 8, are arranged in a special chamber, which is connected with the rooms to be cooled, by wooden air ducts, as in Fig. 9. A fan or blower is provided, which draws the air from the highest or warmest part of the rooms and, forcing it through the cover, brings it in contact with the cold coils, where it is cooled and dried. The cooled air leaves the cooler, and is discharged back into the rooms from which it was taken. To prevent the pipes from becoming enfrosted, each coil is provided with a drip gutter from which brine is showered over the coils, trickling from one layer of pipes to the other, and finally collecting in a pan, from which it is drawn by a small centrifugal pump and returned to the gutters, to be showered again over the pipes. The brine also absorbs and destroys all impurities contained in the air, so that only pure, cold air leaves the cooler. This shows the undeniable excellence of the method of cooling by direct contact between air and brine.

Another application of far-reaching commercial significance is the manufacture of ice. This subject, on account of its importance and general interest, is reserved for special treatment in another article.

The Economy of High-Speed Steel

By FREDERICK W. TURNER

Formerly Instructor, Rindge Manual Training School, Cambridge, Mass.

IN the finishing process in the machine shop, there has been a wonderful development, during the past few years, in the rapidity with which metal can be removed, as well as in the character of the surfaces obtained. For many years, tools made from cast steel, crucible steel, or tool steel (all these names referring to steel of practically 1 per cent carbon) were the only tools that could be employed in the machine shop for the removal of metal. The good old tempered steel tool did its work well, and, in spite of the development of other steels, it has not by any means been entirely superseded. One of the great advantages of the old carbon tool steel lies in the fact that its manufacture and use have covered so long a period of time that the quality of the steel in the bar, and the results obtained by the shop smiths, have become very uniform.

Tungsten Steel

The first indication of improvement on carbon tool steel, in the line of ability to "stand punishment," was the introduction of the so-called "Mushet" steel, some fifteen or twenty years ago. This was a steel containing, in addition to the elements usually found in tool steel, a certain percentage of tungsten. The name "Mushet" was applied to the steel on account of the fact that R. Mushet of Sheffield, England, was the most prominent manufacturer of this grade. Tungsten steel has several peculiarities that distinguish it from carbon steel. It is an extremely hard steel, and cannot be easily forged. It has the peculiar property of being always hard; that is, when heated and forged, it resumes its hard condition after slow cooling. Dipping it when at a red heat, in water, will almost invariably cause the steel to fly in pieces. On the grinding wheel, tungsten steel shows a dull red spark entirely different from the spark given off by carbon tool steel. Owing to its permanently hard condition, forging and grinding were the only processes by which tools could be shaped, and consequently this steel was used for lathe and planer tools almost exclusively. During recent years, methods have been found for annealing tungsten steel to a limited degree, so that its use is no longer limited by its hard and brittle nature. Another point of difference that calls for consideration is that of price. The best carbon tool steel costs about fifteen cents per pound, while the tungsten steels are worth about forty-five cents per pound.

The results obtained by the use of tungsten steel were of great importance. The steel would stand a very much higher temperature than carbon steel before losing its edge. Therefore—for "roughing" cuts, especially—it was found that considerable time could be saved by cutting at a higher rate of speed. It was discovered, however, that the tungsten steel would not maintain a clean, sharp-cutting edge suitable for light finishing cuts, so well as the carbon steel would do. Therefore the use of tungsten steel was limited almost entirely to the roughing cuts.

Heat Treatment for Tool Steels

Several years ago a process of heat treatment for tool steels—called the "Taylor-White" process—was responsible for another step forward in the rapidity of shop operations. While this process was more particularly adapted to a certain brand of self-hardening steel, it was claimed that its use would improve the heat-resisting quality of any good brand of tool steel. It would be well to note at this point that the whole matter of increased speed of cut seems to hinge on the temperature at which the tool will lose its edge. Owing to the fact that the

Taylor-White process was not generally understood, its use did not become very extended, but it paved the way for the introduction of the modern high-speed steels, which depend for their successful operation on a heat treatment somewhat similar to that employed in the Taylor-

Offset Tool Holder (Right Hand).

White process. There have sprung up a multitude of brands of high-speed steels, which are designated by various names, such as "air-hardening," "self-hardening," "high-speed," etc. The chemical composition of these steels is generally not made public, and there has been a great deal of mystery attaching both to the material itself and to its method of treatment. This is to be regretted as it has prevented a more rapid introduction.

High-speed steel can be annealed, and cutting tools of all kinds can be made from it. In this it differs from the tungsten steel. It is also higher than the latter in price, costing about seventy-five cents per pound. To speak of the economy of high-speed steel at such a price, implies, of course, that the results must fully warrant the outlay. It is believed that the judicious use of high-speed steel is in reality economical. By judicious use is meant use where the results are clearly superior to those obtained by the employment of the cheaper and slower working steels.

On account of the high price of these improved grades, it has been found economical to use the steel in small sections which can be carried in a case-hardened mild-steel holder. Typical examples are shown in the accompanying illustrations. While these holders are very handy, and certainly save large amounts of costly steel, still they cannot be made as rigid as a solid forged tool; and, for the very heaviest work, a tool forged from the solid is still preferred. High-speed steel, however, is very brittle, and, if forged solid, should be carried out to the cutting edge in as large a section as possible. If used in a holder, it must be supported very nearly out to the cutting edge.

Holders for this costly steel usually provide means of clamping by a set screw. Some method of doing away with the vibration inseparable from a screw is desired; and it has been suggested and proven to be good practice to solder or braze small pieces of high-speed steel onto soft steel shanks. This has in many cases proved very satisfactory.

The Test of Results

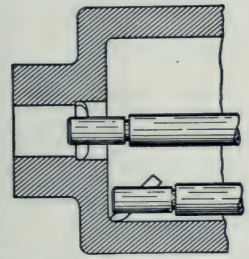
There have been so many extravagant claims made in regard to results alleged to be accomplished by the use of high-speed steel, that many men have concluded that this steel could not possibly fulfill them. As a matter of fact, in many cases cited, it cannot. Actual results, however—sufficient to establish the economy of these steels—can be obtained in abundance, and a few general figures on relative speeds may prove of value. With ordinary carbon steel tools, an average figure for the cutting speed would be about 20 feet per minute for mild steel, 30 feet per minute for wrought iron, and 40 feet per minute for cast iron. These figures, of course, are merely approximate, but they fairly represent average practice. By the use of tungsten steel, the speed for roughing cuts was increased about fifty per cent, while heavier cuts, also, could at the same time be taken. The later high-speed steels, however, show great improvement over these figures, the speed for roughing cuts being increased to about 50 feet a minute for mild steel and wrought iron, and 75 to

Offset Tool Holder (Left Hand).

80 feet per minute for cast iron. Finishing cuts, especially for mild steel, can be taken at rates which appear to be little short of marvelous, a speed of from 150 feet to 200 feet per minute being not uncommon in the finishing of mild steel.

One of the peculiar things connected with the development of high-speed steel, has been the simultaneous development of grinding. The process of grinding has no place in this article, but it may be

noted that the high-speed steels are being extensively used for roughing cuts, while the finish is obtained by grinding. As an instance of work of this character might be cited the turning of cast iron at a cutting speed of 75 feet per minute—depth of cut ⅛ inch, with a feed of ¼ inch per revolution, leaving 1-32 inch over the correct size at the bottom of the groove. The finish obtained by grinding is superior to, and more rapid than, that secured by fine turning, filing, and polishing.

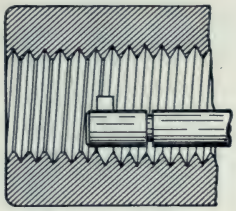


DOUBLE-ENDED CUTTER ROUGHING OUT CORED HOLE. ALSO ANGLE CUTTER BORING AND FACING END.

People have become discouraged—in some instances, possibly, disgusted—with high-speed steel, on account of the oft-prevailing tendency of human nature to wish to get something for nothing. There are many brands of this steel, and the methods of working, especially as far as the heat treatment is concerned, are as numerous as the steels themselves. Nearly all steel salesmen, even if they do not insist on leaving a sample of their steel, are perfectly willing to do so; and the result is that the tool room soon acquires a collection from which the identifying marks are almost sure to be lost, whereupon there is trouble for the tool dresser and the machinist. It is not intended by this to advise the exclusion of new materials and processes, but more particularly to recommend keeping the experimental and the commercial ends of one's business separate and distinct from each other. It is well to try thoroughly all brands of steel offered; but it is not wise to have more than one brand for shop use.

The steel salesman, also, in numerous instances, is inclined to make claims for his particular brand, which claims, in many cases, cannot be substantiated. This does not imply that the results will not show a distinct advantage over the old carbon steels. The purchaser should not expect to obtain results fully equal to those claimed by the agent, the claims of the salesman being generally based on short laboratory tests, and sometimes, it is to be feared, colored to suit the prospective purchaser. If a substantial saving in time can be made, there is economy in the use of high-speed steel, and the fact that still better results than this are claimed, does not prove that its use is not economical.

There is an economy in the use of this steel which, while it may be attributed to the material, is in a sense not directly concerned with its use. It is a well-known fact that so simple a matter as speeding up the shafting has a tendency to quicken the life of the whole shop. This is true not only as regards the actual output of the machines; but it also actually quickens the physical movements and mental grasp of the workmen themselves.



TOOL CUTTING A THREAD.

In a recent address before an engineering society, a speaker used this expression, "High-speed steel is developing high-speed machinists." This remark is strictly true; and, although the introduction of this steel will be opposed by the slothful workman, its influence upon the great majority of men will be distinctly beneficial.

To sum up in a word, the economy of high-speed steel may be said to comprise saving of time in the machine operation; better mechanical results, especially if we include the simultaneous development of grinding; and, finally—perhaps the most important of all—the quickening, physically and mentally, of the workman.

GENERAL VIEW OF WORCESTER POLYTECHNIC INSTITUTE, WORCESTER, MASS.

Great Technical Schools

Worcester Polytechnic Institute

By LEVI L. CONANT, Ph. D.

Professor of Mathematics

WORCESTER POLYTECHNIC INSTITUTE, Worcester, Mass., was founded in 1865, by John Boynton, of Templeton, Mass. It has since received gifts from citizens of Worcester, supplemented by state donations, which have made possible the enlargement of its facilities for instruction and enabled it to keep pace with the tremendous progress that has been taking place in the last thirty years in all matters pertaining to professional and technical education. In some respects it has been and is a recognized leader; its methods have been extensively copied; and its graduates have found ready employment in more recent foundations of a similar character. Its facilities are not inferior to those of any other Engineering School, considered either as a means of educational discipline or for the training of the technical expert.

The courses of study offered are designed to meet the wants of those who wish to become Mechanical Engineers, Civil Engineers, Electrical Engineers, or Chemists, and also, incidentally, of those who desire to become mathematicians, physicists, or designers.

The Institute owes its origin and character to a conviction on the part of its founders and those who have since directed its course, that the then little thought of, but now almost universally adopted, "laboratory" methods of instruction are likely to produce far better results than those previously in use, especially when applied to the preparation of young men for the technical professions. The underlying principle which controls the work of the Institute is that

courses of study and laboratory exercises may be arranged which will furnish all the intellectual training that is of real use in the so-called "liberal" education, and which will at the same time equip the young man with a good knowledge of the sciences specially relating to his chosen profession, together with a considerable amount of actual practice in that profession; and, as the latter is always under the direction of competent instructors whose sole object is instruction, and as recognized skill of more than a thousand graduates.

The importance attached to laboratory methods in connection with the various courses of the Institute is shown by the number and equipment of the buildings which are devoted, for the most part, to this work.

On a tract of land about twelve acres in extent in the northwestern part of the city of Worcester, on an elevation which provides a beautiful site for the purpose,

MACHINERY DEPARTMENT, WASHBURN SHOPS.

it advances side by side with the student's knowledge of the theoretical principles involved, this practical training must necessarily be, hour for hour, many times more productive and valuable than professional experience acquired under the old method.

After an experience of more than a quarter of a century, shared as it has been in later years by nearly every institution of learning in the country, the validity of this general principle is attested by the professional standing and

are situated seven buildings devoted to the work of the Institute. These buildings are as follows:

Boynton Hall

devoted to the offices of administration, the Library of General Reference, recitation rooms, and the rooms of the Department of Civil Engineering.

The Washburn Shops

including wood, machine, and forge shops.

In the use of a workshop as furnishing an essential part of the training of the Mechanical Engineer, this institution was the pioneer in this country, and its facilities for this training as embodied in the Washburn Shops are probably at the present time more extensive than are to be found in any other.

The Shop buildings contain 33 rooms, including blacksmith shop, tool rooms, drafting and designing rooms, painting and finishing rooms, and large machine-tool rooms for work in both wood and metals.

IN THE FORGE SHOP.

The Woodworking Department is equipped with benches, each supplied with hand tools. A full equipment of the latest forms of machine tools, comprising planers, saws, mortising machines, and all other machines necessary for working in wood, is available.

In the machine rooms are lathes, planers, shapers, milling machines, drills, gear cutters, and a full supply of standard gauges, threads, and measures.

In the forge shop are forges and heavy vises, shears, and swage blocks, for use in common.

The Foundry

erected in 1902, a brick and granite building with structural work of steel, connected with the Shops by means of a tunnel. It is equipped with cupola furnaces, crucible furnaces, cranes, hydraulic elevator, core ovens, pickling vats, and rattlers. It is complete in every respect, and is believed to be the most modern foundry equipment possessed by any educational institution in the country.

The Washburn Shops, besides furnishing the student with practical work, are conducted as a business enterprise, and are engaged in the manufacture of standard machine tools on a commercial basis, giving employment in wood and machine shop, in forge and foundry, to a large number of skilled workmen, and thus affording the students constant contact with commercial methods and standards.

The Salisbury Laboratories

devoted to the Departments of Chemistry, Physics, and Electrical Engineering, a four-story building fully equipped for the uses of these three departments.

The Department of Chemistry is amply provided with rooms and laboratories for carrying on its special work. These include general, analytical, organic, industrial, sanitary, and gas laboratories, and many rooms well equipped for research work.

To the work in Physics are devoted laboratories for elementary and advanced work, lecture and recitation rooms, and

small rooms for meetings, photography, photometry, spectroscopy, and special research.

To the work in Electrical Engineering are devoted a dynamo laboratory, alternating-current laboratory, workshop, store room, electrical engineering laboratory, offices, drafting and designing room, lecture room, and battery and furnace room.

The Foundry.

The Mechanical Engineering Laboratories

with a basement and three floors. Here are situated the Hydraulic Laboratory, erecting and testing laboratories, Cement-Testing laboratory, a laboratory for testing materials of construction, a laboratory for testing properties of small samples of metals and other materials, and a general laboratory for experiment and research in connection with engineering processes. Besides these, the building contains a mechanical drawing room, a model room, and a room for machine design.

The High Potentials Laboratory

containing a transformer, designed and made in the Electrical Engineering Department of the Institute, capable of producing a potential of 500,000 volts—the highest voltage yet attained anywhere—which is in use for experimental purposes in connection with the work in the Electrical Engineering Department.

The Power Laboratory

centrally situated, containing a boiler room, a room for the generation of power by means of a gas engine, an engine room with steam engines and dynamos for electric light and power, and a sub-basement for receivers, condensers, and steam pipes. This building is connected by tunnels with all of the other buildings, and supplies all of them with heat, light, and power.

In addition to these, the buildings of the Institute include a dormitory, known as

Newton Hall

a short distance from the Institute; and

The Hydraulics Laboratory

situated at Chaffinsville, about five miles distant, containing an 80-H. P. turbine, meters, weirs, and other apparatus used in conducting hydraulic tests and experiments. Here the Institute owns a water privilege which makes it possible to conduct hydraulic experiments at suitable seasons of the year with a head of water sufficient for all practical purposes on a commercial scale.

Libraries

Besides the extensive Library of General Reference and the Department Libraries of the Institute, the Free Public Library of Worcester, containing 140,000 volumes, the Library of the American Antiquarian Society, of Worcester, containing 100,000 volumes, and the Library of the Worcester County Mechanics' Association, are accessible to students and all others connected with the Institute.

In the Foundry.

DEPARTMENT OF PHYSICS, LABORATORY A, FOR JUNIOR WORK.

Courses of Study

The Institute offers four-year courses of instruction in Mechanical Engineering, Electrical Engineering, Civil Engineering, Chemistry, and General Science, upon the satisfactory completion of any one of which the Degree of Bachelor of Science is conferred.

THE HIGH POTENTIALS LABORATORY.

The work of the Institute is carried on under the direction of a Faculty of seventeen professors, fourteen instructors, and numerous assistants in the laboratories. The work in all courses is based on a broad foundation of Mathematics, French, German, English, Chemistry, Drawing, Physics, Political Science, and Civil Government.

Instruction is given by means of textbooks, lectures, recitations, conferences, and practical work in workshops and laboratories. Each course requires, as a condition of graduation, the preparation of a thesis involving original research.

Postgraduate courses are also given leading to the degrees M. S., M. E., E. E., C. E., and D. Sc.

Student Organizations

A branch of the *Young Men's Christian Association* has had a long and flourishing existence at the Institute. Weekly meetings are held.

The *Athletic Association* has general charge of all athletic matters among the students. Football, baseball, basketball, track athletics, and tennis are encouraged within proper limits. Officers are chosen from among the students, acting with an Advisory Board of members of the Faculty and Alumni.

The *Mechanical Engineering, Electrical Engineering,* and *Civil Engineering Societies* of the Institute hold fortnightly meetings. Addresses are given by students, alumni, resident and non-resident Engineers, and others whose experience and training are along lines of work re-

lated to Engineering in its various branches.

The Greek letter Societies are represented at the Institute by the *Phi Gamma Delta* and *Sigma Alpha Epsilon* fraternities, each of which has a Club House of its own.

Publications

The Institute publishes an *Annual Catalogue,* giving full information concerning details of the courses of instruction, equipment, occupations of Alumni, and all necessary information. It is supplied gratis on request.

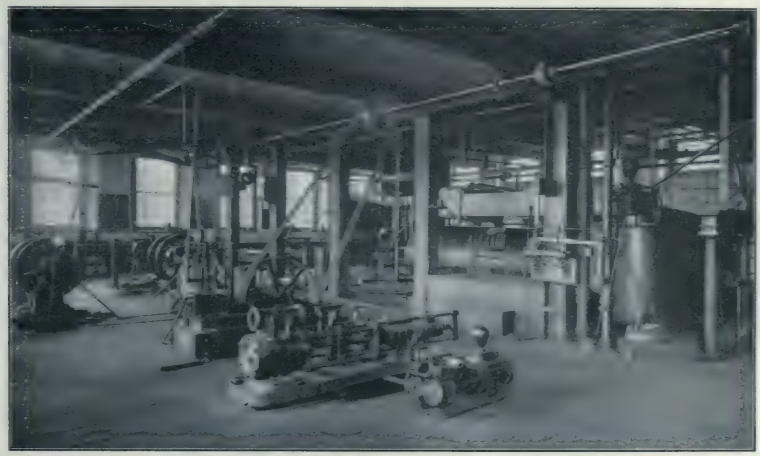
The Institute publishes also an illustrated pamphlet containing some twenty views of buildings, laboratories, and grounds, accompanied by descriptive statements.

The students of the Institute, under the direction of a Committee of the Faculty, publish a bi-monthly magazine called *The Journal of the Worcester Polytechnic Institute,* which is devoted to engineering and scientific progress and contains articles of value to the engineering profession as well as a current account of Institute activities.

The Alumni of the Institute now number over a thousand, of whom over 90 per cent are engaged in work for which their training at the Institute actually fitted them.

Among the earlier graduates are to be found superintendents, managers, partners, and proprietors of almost every variety of industry. Many are chief engineers, chief draftsmen, and designers. More than a score are practicing lawyers, chiefly patent lawyers; and almost without exception these have served as Examiners in the United States Patent

THE POWER LABORATORY.



MECHANICAL ENGINEERING LABORATORY.
Secondary Steam, Hydraulic, Gas-Engine, and Compressed-Air Apparatus.

Office, where there are always representatives of the Institute Alumni.

The more recent graduates begin their demand for graduates of the Institute is constant, and at times is far in excess of the available supply.

IN THE ELECTRICAL LABORATORY.

life work as foremen, draftsmen, inspectors, and assistants in office, shop, field, and laboratory. Many in recent years have entered the profession of teaching

IN THE POWER LABORATORY.

along the lines of drawing, mathematics, science, mechanical engineering, or electrical engineering, and are now filling important positions in High Schools, Normal Schools, and Universities. The

Prosperous Alumni Associations have been organized in Worcester, Boston, New York, Philadelphia, Washington, Chicago, Cleveland, and San Francisco.

The activities of the Institute extend far beyond the limits of actual instruction of students, inasmuch as members of the Faculty are frequently called in consultation in important scientific, engineering, and commercial work outside of the Institute. The reputation of the members of the Faculty in their special fields causes great demand for their services as consulting engineers and specialists.

One of the first schools of its class in this country, the Worcester Polytechnic Institute, is still in the front rank of Engineering Schools, although the progress that has taken place during the past quarter of a century in all matters pertaining to professional and engineering education has been very great.

In the management of the workshops, as well as in its physical, chemical, engineering, and other laboratories, the In-

stitute is an exponent of modern progress; and it is confidently believed that in the execution of the general plan outlined above it offers advantages for thorough practical training that are well worthy of being considered by all who contemplate entering one of the branches of the profession of engineering. Within a few years its courses of study have been enlarged and extended, its facilities for instruction more than doubled; and under the direction of its President, Dr. Edmund A. Engler, and its corps of able teachers and investigators, the Worcester Polytechnic Institute is sure to remain—as it has heretofore been—a very important factor in the development of professional and technical education.

Riveted Joints

Fundamental Principles of Important Details of Boiler Construction

By CARL S. DOW, S. B.

Instructor in Mechanical Engineering, American School of Correspondence

THERE are various forms and strengths of riveted joints used in boiler work, but practically all belong to one of two classes—the "lap" joint and the "butt" joint.

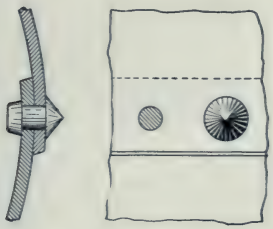


FIG. 1.

Lap and Butt Joints

If one plate overlaps another and is riveted to it by a single row of rivets, as shown in Fig. 1, the joint is called a "single-riveted" lap joint. This joint has a little over half the strength of a solid plate. If another row of rivets is added, we have what is called a "double-riveted" lap joint. Fig. 2 shows a double-riveted lap joint chain-riveted, and Fig. 3 a double-riveted lap joint zigzag-riveted. Double riveting is done in two ways: zigzag or staggered, and chain. When the rivets of one row are opposite the spaces of another row, the riveting is said to be "zigzag." If the rivets are placed directly opposite each other, it is called "chain" riveting.

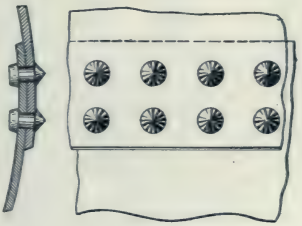


FIG. 2.

If the two plates are kept in the same plane and a cover or butt-strap is riveted on, we have "butt" riveting; in Fig. 4,

A and B are the boiler plates and C the butt-strap. If an inside butt-strap is added, the joint is called a "double" butt joint (see Fig. 5). Fig. 6 shows a treble-riveted butt joint. A single butt

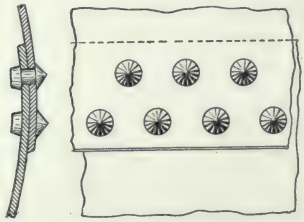


Fig. 3.

joint is about equal in strength to a lap joint, having but one row of rivets, but a double butt joint is considerably stronger. In this latter form of joint the rivets have double shearing surfaces since they tend to shear off in two planes. This either makes a stronger joint or allows the use of smaller rivets.

In the single butt joint, the butt-strap is usually about 1⅛ the thickness of the plate; and if the inside butt-strap is added

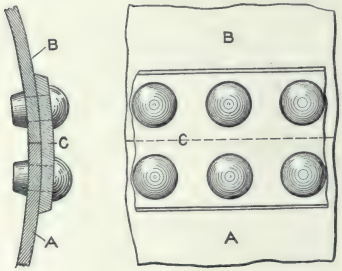


Fig. 4.

each is made about ⅝ the plate thickness. Butt joints are now used in the best class of boilers, and are almost the only joint used for plates less than ½ inch in thickness. For high pressure in marine boilers, triple riveting is frequently used.

If the cover-plate is riveted on the outside of a lap joint, it is called a "combined" lap and butt joint. In this case there are three rows of rivets, the middle row having twice as many rivets as the outer rows.

It can be proved that a boiler tends to rupture longitudinally. The reason for this is that the resistance of a thin cylinder to a circumferential rupture is double the resistance to a longitudinal. Since this is the case, lap joints are used for transverse seams; and the stronger form—the double butt joint—is used for longitudinal.

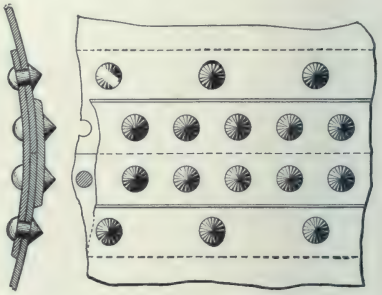


Fig. 5.

Arrangement of Plates and Joints

At the junction of three or more plates, where the circumferential and longitudinal joints meet and are riveted, the joint would under ordinary conditions be too thick. To overcome this difficulty, two or more of the plates are forged thin, as shown in Fig. 7.

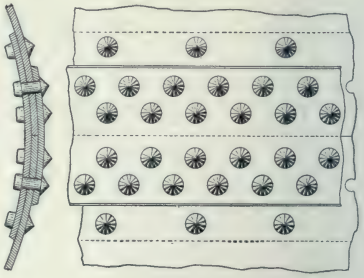


Fig. 6.

Whenever longitudinal and girth seams meet, the plates should be arranged to "break joints;" that is, one longitudinal seam should not be a continuation of another; the proper arrangement is shown in Fig. 8. In both vertical and horizontal boilers the inside lap is made to face

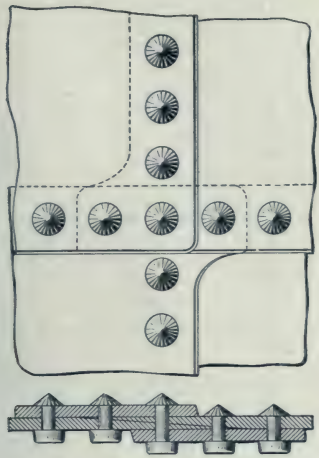


FIG. 7.

downward so that it will not form a ledge for the collection of sediment.

The belts of plates that make up the length are sometimes arranged conically with the outside lap facing backward. When the boiler is slightly inclined toward the front end, this conical

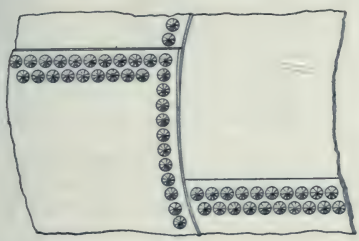


FIG. 8.

arrangement facilitates draining and cleaning, as the dirt is removed from the front end. This is a great advantage in internally-fired boilers, as this type is difficult to clean. In long, vertical boilers the ring seams are arranged with the inside lap facing downward, so as not to form a ledge for sediment.

Of late years, boiler-makers use larger plates than formerly. This is advantageous especially in externally-fired multitubular boilers, as the single seam is placed above the water line, and therefore is away from the fire.

The portion of the boiler between the shell and the furnace is called the "water leg." Figs. 9 to 13 inclusive illustrate the method of construction of the water

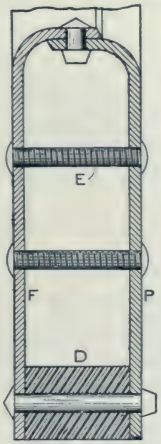


FIG. 9.

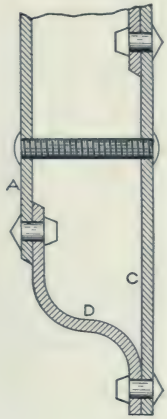


FIG. 10.

leg and the joints around the furnace door. Figs. 9 and 10 show two methods of constructing the water leg. In Fig. 9, the external plate P and the furnace plate F are riveted to the ring D by means of long rivets. This ring is usually made of wrought iron, although in cheap boilers it is of cast iron. In Fig. 10, the

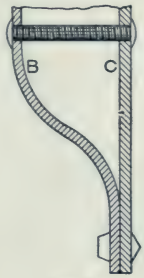


FIG. 11.

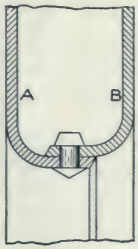


FIG. 12.

two plates A and C are riveted to the flanged ring D. This construction is better than the solid cast-iron ring, on account of flexibility; but the junction of plates C and D forms a corner in which sediment is deposited. In Fig. 11, plate B is flanged and is riveted to plate

C. This arrangement requires less riveting than the one shown in Fig. 10.

Figs. 12, 13, and 14 show three forms of construction of the joints around the furnace door. In Fig. 12, both the exte-

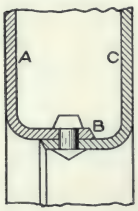


Fig. 13.

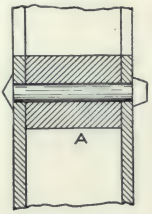


Fig. 14.

rior plate B and the furnace sheet A are flanged and are riveted together. The construction shown in Fig. 13 is not so good as that in Fig. 9 because of the extra riveting; also it has two corners, B and C, for the deposit of sediment. Fig. 14 shows a somewhat different form of furnace construction, the two plates being riveted to the cast-iron ring A. This makes that part of the boiler too rigid, but it has the advantage of not having rivet-heads to wear. In these methods of riveting, the constructions which have the flanged ring are preferable to those using the cast-iron ring, because of the freedom provided for expansion.

In almost every boiler, plates must be connected at right angles. An illustration of this principle is seen where the end plates are joined to the shell plates of cylindrical boilers. There are three principal methods—(1) riveting both plates to an angle iron; (2) riveting to a flanged ring; and (3) flanging the end plate. In Fig. 15 the two plates are riveted to an angle iron, which is made either of wrought or cast iron. This construction is too rigid; the constant variations of temperature cause repeated changes of form which tend to crack the angle iron on the inside of the plate and at the joint. Corrosion increases the evil, as it rapidly attacks iron which has once been cracked or broken.

The forms shown in Figs. 16 and 17 are better, and are frequently found in the common multitubular boiler and in the return-tube marine boiler. The head is flanged and is riveted to the shell plates. This flanging makes a more flexible joint. The radius of the curve of the flange should be about four times the thickness of the plate. The head and shell are sometimes connected to a flanged ring, as shown in Fig. 18, but the extra row of rivets makes a complex joint.

In large, vertical boilers the external fire-box is joined to the cylindrical shell by riveted joints. Figs. 19 and 20 show two forms, that in Fig. 19 being the better on account of the flanged ring, which allows expansion and contraction of the shell and furnace plates.

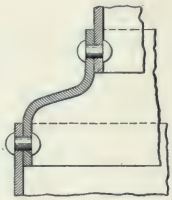


Fig. 19.

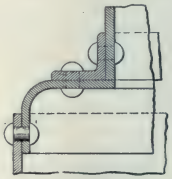


Fig. 20.

Sometimes the case occurs of connecting two plates which are parallel and near together. For instance, at the bot-

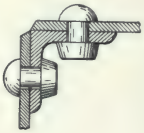


Fig. 15.

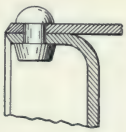


Fig. 16.

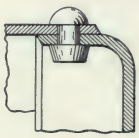


Fig. 17.

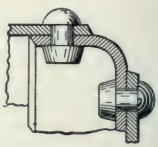


Fig. 18.

tom of the locomotive fire-box a connection must be made between the inner and outer fire-box. The water-leg construction is a similar instance. Several methods are shown in Fig. 21. That illustrated in Fig. 21A is too complicated,

and is undesirable both on account of the numerous rivets and angle irons and on account of the inside joints which can-

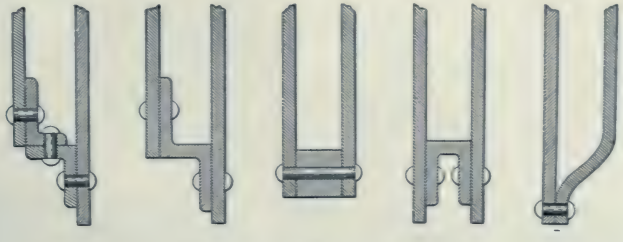


FIG. 21.

not be calked. The method shown in Fig. 21B is better, since but one angle iron is used. It has, however, the undesirable inside joint. Fig. 21C shows a construction similar to that shown in Figs. 9 and 14; this makes a good joint, but is too rigid. Fig. 21D is a good joint, the form of connection being called a "channel iron." Fig. 21E, as we have seen, shows a good flexible joint, but one which, as already stated, has the undesirable corner for the collection of sediment.

How Electricity is Taught at Tuskegee

A Description of the Methods of Technical Training Employed at this Famous Alabama School, which, under Principal Booker T. Washington, is Doing a Work of Inestimable Value for the Education and Elevation of the Colored Race in America

By CHARLES W. PIERCE, B. S.
Instructor in Electrical Engineering.

THE course in Electrical Engineering at Tuskegee Institute was started in 1898, when an electric plant was installed in order to meet the need of the school in the lighting of the dormitories and other buildings, class rooms, and grounds.

There was great danger of fire when oil lamps were used, on account of the carelessness of students in handling the lamps, so that the Electrical Engineering Department was a necessity. After it was decided to have an electric plant, and the dynamo had arrived, a small number of students were permitted to work with the electrician in charge, in order to assist him and also learn Electrical Engineering. These students were first taught house wiring because none of the buildings had been wired. The simplest form of wiring—consisting of cleat and moulding wiring—was adopted, and the instructor employed these students to assist in running the plant at night.

The first dynamo used by the school was a 50-K. W. monocyclic alternator furnishing 43 amperes at 1,040 volts. This style of dynamo was chosen because the buildings to be lighted are scattered over a large area of ground, and this type of machine is adaptable to the use of motors.

A course of study covering three years was thought sufficient to teach the student the elements of Electrical Engineering, and to make first-class electricians out of them.

After the completion of this course of study a certificate is granted to the student, which states that he has completed the course in Electrical Engineering of the Tuskegee Normal and Industrial Institute. The school does not give any degree, but the certificate indicates that the bearer is a first-class electrician.

The electrical equipment of the Institute consists of a 50-K. W. monocyclic alternator, with exciter and switchboard; a 7-K. W. Brush arc-dynamo exciter;

HUNTINGTON HALL—A GIRLS' DORMITORY. THE GIFT OF MRS. C. P. HUNTINGTON.

annunciator systems; watchman's time clock; electric storage battery; various primary batteries; galvanometers; voltmeters; ammeters; wattmeters; enclosed arc lamps; and a telephone exchange.

The Electrical Engineering Department has proved quite attractive to students from foreign countries as well as from the other states of the United States. In this department are enrolled students from Haiti, Jamaica, Porto Rico, Cuba, and from the states of Alabama, Georgia, Louisiana, Tennessee, Kansas, Texas, Indiana, Illinois, Montana, and the District of Columbia.

Rockefeller Hall Boys' Bathroom Olivia Davidson Hall Porter Hall Science Hall

Teachers' Cottages.

A PORTION OF THE CAMPUS OF TUSKEGEE INSTITUTE.

It will probably be interesting to know how the students first heard of Tuskegee; what they are able to do in their work; and what they intend doing after leaving the Institute. We quote from letters recently received, which cover these points more or less fully. The first letter is from a young man in Haiti, who writes as follows:

"Electrical Engineering is one of the branches of scientific knowledge least in vogue in Haiti. There exist the telephone, the telegraph, and some small electric plants. While in school, I desired to come to America to study practical science and learn a trade. After finishing I heard that Tuskegee was a place which afforded excellent opportunities to the negro for acquiring practical knowledge. I arrived at the Institute, September 1, 1903.

"I can install electric bells and annunciators, trim arc lamps, wire buildings, and assist in running the dynamo. When I leave Tuskegee I shall attend some other school to pursue my studies still further, and shall then return to Port au Prince, Haiti, my home, for work at my trade."

This young man from the West Indian island could speak only French last September, but now he can speak English quite fluently.

Another young man writes:

"I came to Tuskegee September 9, 1902. Hearing of the advantages which Tuskegee offered for one wishing to become an Electrical Engineer, I decided to go and avail myself of the opportunities. I can wire buildings, run direct- and alternating-current dynamos, trim arc lamps, and repair telephones. After leaving I intend to attend some other school, and then follow my trade either as a station manager or electrical contractor."

All students that enter the division are required to take studies in the Academic Department, exception being made in the case of post-graduates; and they must complete a certain requirement in academic studies before they can receive a certificate from the division. The Academic Department has two distinct schools—the day and night schools.

When a student enrolls in the day school, he spends one-half of his time in the Academic Department, and the other half in the Industrial Department. When he enrolls in the night school, he spends all day working at his trade, and his evenings in academic studies.

When a student enters the school and desires to learn a trade but is unable to pay his tuition, he may enter the night school. He receives small wages for the work that he does, and very soon establishes a credit in the School Treasury. When his credit is sufficient to pay his necessary tuition and expenses, he enters the day school, in which students advance much faster in their academic studies but not so fast in industrial work.

A great deal of stress is laid upon the quality of work the student does in the division, from the fact that the work is real work and must serve the purpose for which it is performed. This may be illustrated from the installation of an electric plant. From the time the dynamo arrives on the ground, it is a part of the Electrical Division; and the installation, running, and all repairs must be done by the students working in the division.

When the present plant was installed, a pole line had to be constructed. The Instructor took his students to the woods and had them fell the trees. He then required them to prepare the poles for the line, make the cross-arms, and erect the electric line. The students were in this way taught line construction.

The transformer station was next installed, and the distributing lines laid out. The station was provided with all necessary appliances, such as primary cut-out boxes and fuses, lightning arresters, and secondary knife switches. The three-wire system from the transformers was used, on account of the distance of the buildings from the transformer station.

Special care and instruction are given to see that the students wire the buildings according to the latest rules of the National Board of Fire Underwriters.

New buildings are being constructed from time to time, and in these buildings the latest methods of wiring are adopted.

CHARLES W. PIERCE.

The students have done cleat, moulding, brass-armored-conduit, flexible-metallic-conduit, and iron-armored-conduit wiring—a variety of forms of wiring being selected in order to familiarize the student with the different methods.

There are at present thirty-four buildings lighted by electricity, with a total of 1,717 lights. The division supplies lights to several places off the school grounds, among these being the residence of the late Col. Charles Thompson, Congressman from this district, the Tuskegee railroad station, and a church. The residence of Colonel Thompson is situated two miles from the electric plant. There are 34,000 feet of primary line, 22,000 feet of secondary line, and 8,000 feet of street-light wiring used. Until recently the street lighting was done with 32-candle-power incandescent lamps connected to the secondary lines wherever convenient; but, on account of the overload on the dynamo used for lighting the buildings, and also because the lights were

lighted on the streets when not needed, these lamps were taken off the secondary line and connected to the Brush arc dynamo.

A course in Telephony was made possible on account of the school's need of quick communication from building to building and between the offices. A 25-subscriber exchange was therefore installed, and this branch of Electrical Engineering was added to the division, which gives the student experience in telephone work. The exchange was installed and managed by the school until recently, when the Southern Bell Company contracted with the school to furnish it long-distance connection and with the company's switchboard.

The school had the first colored "hello girl" (to the writer's knowledge) in the world.

by giving him a theoretical knowledge of his work.

The following will illustrate how this is being accomplished:

We are at present building a 100-light direct-current dynamo to furnish current at 110 volts. In the theory classes, the design of the machine, the drawings, and the calculations are made. The drawings then go to the patternmaker, who gets out the patterns; and these to the foundry, where the castings are made; the latter then go to the machine shop, where the necessary machine work is done; and finally, the parts are taken back to the Electrical Division, where the machine is assembled. During each operation the student follows the machine, and in the end sees a finished machine designed by himself and finally operated by himself.

The Electrical Division grows with the

ANOTHER VIEW OF THE CAMPUS.

The laboratory methods are discussed and verified in the theory classes, and are finally made use of and pointed out in the work that the student does. While the student is at work he is encouraged to ask questions about the work; and he is questioned in turn, to make sure that he does understand all the operations that take place in the work. In this way the division is endeavoring to raise the workman above that of the plain, practical man

school. The present plant has become too small to light all the buildings; and at present another monocyclic alternator of 150-K.W. capacity is being installed. This new alternator is to work in parallel with the present one when needed, and will supply all the buildings with electric lights.

Although the alternating-current system is being used, there is a difficulty in teaching this system to the students, as

STUDENTS AT WORK.

Moving the 150-K. W. alternator into dynamo room. Instructor with star on coat at right.

many are in the lower academic classes. The students that enter the Electrical Division are not classified as they are in their academic work; and it often happens that a student in the lower academic classes takes theory class-work with the student of higher academic standing. The problem then arises as to the best methods of teaching these two groups of students in order that their advancement shall be equal.

The electric plant is run by the advanced students in the division, with the less experienced as helpers.

The duties assigned at the plant are those of chief electrician, first assistant electrician, second assistant electrician, and morning electrician. The hours of running are from sundown to 10:30 P. M., and from 4:30 A. M. to sunrise.

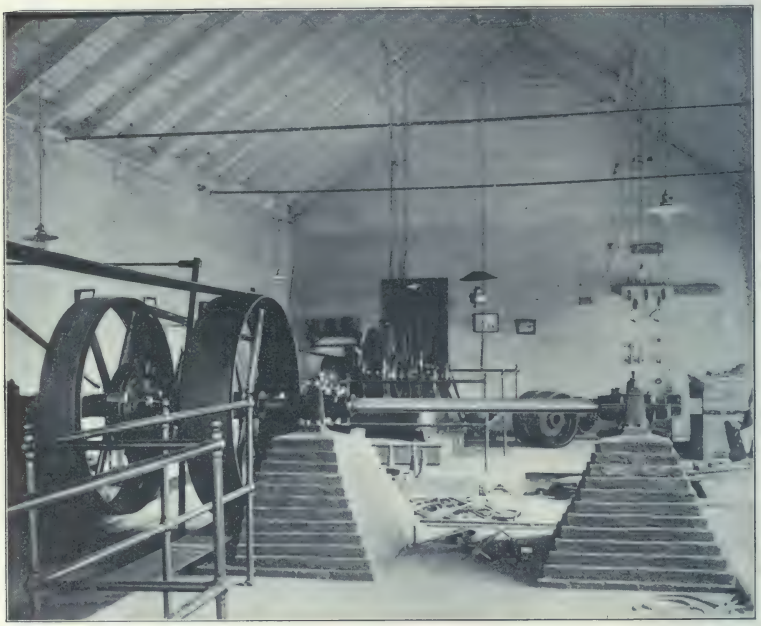
The plant has been operated very successfully, with no accident to anyone; neither has there been any time when a long stoppage was necessary. It must be remembered that the plant has been operated for six years, and that it is a single-unit plant. It requires very close inspection of the machinery and of the work of the students in order to keep the plant in running condition; and the students learn more from this system of inspection and criticism than would be possible by any other means.

The running expenses of the plant amount to about 4.5 cents per kilowatt-hour, although the price of coal is $4.00 per ton for a very poor grade of bituminous.

Although there are 1,717 lights connected to the system, rarely ever do more than 850 lights burn at a time. This is made possible by the close schedule for use of the lights. There are three distinct consumers—the dormitories, the Academic Department, and the workshops. No two of the light consumers

use lights at the same time. The close supervision of the carrying out of the schedule falls to the Electrical Division, and the duties assigned to the young men of this division are to prevent a waste of electrical power.

The Academic Department is one of the largest consumers of electrical power, and when it is finally housed in its new building, it will use 600 lights. Flexible metallic conduit is now being installed in the building, and Frink reflectors will be employed in lighting it. There are three floors and a basement to this building, giving about 75 rooms for academic classes, laboratories, chapels, and a gymnasium. This is the largest building that the Electrical Division has attempted to wire.



VIEW OF DYNAMO ROOM.

Showing switchboard, 50-K. W. alternator, and foundation for 150-K. W. alternator.

The following anecdotes will illustrate the popular conception of the Electrical Engineering Department and the sentiment toward it:

It was during one of the negro conferences which Principal Washington convokes every year at Tuskegee, that the following incidents happened:

We were at work in the dynamo room cleaning up the dynamo for an evening run, when one of the delegates was seen looking in at the door. I wished to make him feel welcome so I stepped to the door and asked him in. He said to me that he was afraid; and when I assured him that he would be perfectly safe, he went on to say that he had "no business fooling around the dynamite machine," because at his home three men had been "killed by the dynamite made from the dynamite machine."

Once, when we were installing a transformer in the grounds, a man wanted to know how the oil could get through the wire to the different buildings when the wire was solid.

Very often new students that enter the

school come from rural districts where they never see any other light than pine knots and candles, and they are naturally quite amazed on seeing the electric lights.

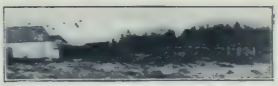
A rule of the school requires all lights extinguished at 10 P. M. For several nights on one occasion, a light had been noticed burning in one of the rooms; and the officer in charge of the building was ordered to investigate and see why the light was not put out on time. When he arrived in the building, he found one of the new students almost out of breath and unable to answer any questions. The student finally recovered sufficient breath to answer the question of the officer, and explained to him the difficulty he experienced in blowing his lamp out, and said further that he had staid up half the night ever since his arrival blowing out his lamp. The real fact is that the dynamo stops at 10:30 P. M., and he thought that he had finally accomplished his task.

Finally, a word should be said as to what the graduates and students of the division do after leaving school. Young men of the division rarely stay to finish their course, on account of the demand for electricians such as the division turns out. Students who have not received certificates are working in Texas, Georgia, Indiana, Illinois, New York, Alabama, Kansas, and Missouri, working as electricians, linemen, dynamo-tenders, electrical repair men, and arc-light men, and in automobile stations. There is no doubt of a student receiving employment

CORNER OF MECHANICAL DRAFTING ROOM.

after completing the course, the only drawback being that the Institute cannot turn them out fast enough.

To sum up, we might say that at Tuskegee Institute students *learn Electrical Engineering by doing Electrical Engineering work.* The Engineering Division is therefore practicing the doctrine of the founder in teaching the dignity of labor and of learning to do things well.



Romances of Secret Inventions

How Some Are Stolen and Others Lost

IF the full history of secret processes could be written, it would surely form one of the most romantic and fascinating books the world has ever seen; and one of the most interesting sections would be that which dealt with the many attempts to steal the secrets from their jealous owners.

The scene of one of these stories is laid in the wild moorland country around Sheffield, England, where a watchmaker named Huntsman had built a factory for making steel by a process of his own invention. The secret was a very valuable one, for it was the only process by which steel could be made of uniform quality throughout; but Huntsman had little fear that any of his rivals would discover it, for he employed only picked and sworn workmen, and the portals of his factory were almost as strictly guarded against strangers as the doors of a bullion vault.

However, one bitterly cold wintry night, when the wind was shrieking over the neighboring moor, driving the snow in wild eddies before it, a tattered, shivering tramp presented himself at the door of the works and pitifully craved permission to warm his frozen bones at the furnace fires. For a long time he pleaded in vain; the doorkeeper was obdurate; but finally importunity and the pathetic aspect of the man won the day, and the tramp was admitted to the warmth, only to fling himself on the floor in utter exhaustion and to fall asleep.

The rascal, however, was sleeping with one eye open, and with that eye he was craftily watching the men at their work, with the result that when an hour later he left the place with words of gratitude, he took Huntsman's secret with him.

Another interesting story takes us to the neighborhood of Temple Bar in London, and to the shop of a chemist who was the only man in England that knew the secret of the manufacture of citric acid. So jealous was he of his invention that he would share it with no one, but worked alone in the laboratory over his shop in Fleet street.

One evening, however, when his processes were well advanced, he locked up his laboratory and left the premises for a time, assured that no one could possibly gain admittance during his absence. But he bargained without a certain uninvited guest who worked his way down the chimney into the laboratory and made such good use of his time that, when he re-emerged from the chimney, he had the manufacture of citric acid at his fingers' ends.

It was in a similar way that the manufacture of tinplate became possible in England—the secret being one which no person had been able to wrest from its owners in Holland for half a century. But there was a bold and crafty Cornishman, one James Sherman, who made up his mind to discover it at any cost. Going over to Holland, he found his way into the factory at great personal risk and brought the secret back safely.

These are but a few of the little romances of successful secret-stealing, and who shall tell the number of attempts that have failed, or even how many lives have been lost in the attempting? Men will risk much to fathom such a secret as that of the monks of the *Grande Chartreuse,* who make the well-known *liqueur* of that name, for which a sum of $10,000,000 has been refused point blank; but the secret has defied all discovery.

Among scores of secret processes just as successfully guarded is that which has given to the world the exquisitely beautiful Dresden china. It is said that not even a king may enter the guarded walls of the factory at Meissen, where the porcelain is made, with the solitary exception of the King of Saxony himself; and every workman is under a solemn oath, to which the severest penalties are attached, never to breathe a word of what goes on within the factory.

Then there is the romance of inventions that have been absolutely lost to the world, of which one example must suffice. An American inventor named Ford, after long years of unremitting labor, had discovered a method of treating ore without smelting, and at a very small cost. So valuable was the discovery considered that fabulous offers were made to Ford for the secret; but, as ill-luck would have it, on the very day on which he had arranged to part with it in exchange, it is said, for an annuity of $100,000, he was struck down by apoplexy and his secret died with him.

SCIENCE and INDUSTRY

THE FOLLOWING semi-humorous statement is taken from *Il Corriere Italiano*, a leading newspaper of Italy, and refers to a statement by A. S. Mackenzie describing England's condition in relation to American industries:

Popularity of American Goods in England

The Englishman, Mr. Mackenzie says, on rising in the morning, shaves himself with Williams' soap, with a safety razor of Yankee make. He puts on North Carolina stockings and shoes from Boston, and throws over his shoulders suspenders from Connecticut. Into his pocket he puts a Waltham or a Waterbury watch, and sits down to his *déjeuner*. He congratulates his wife on having a corset from Illinois and a bodice that comes from Massachusetts. He eats bread made from American flour, ground in the mills of the Great Lakes. He eats bacon from Kansas City and oysters from Baltimore, while his wife cuts a beef tongue from Chicago. And while eating his luncheon he reads his paper, printed by an American machine on American paper with American ink, and probably edited by some lively journalist from New York.

THE QUESTION of improving the German consular service in the interests of trade, was the occasion recently in the Reichstag, of a member setting up the United States as a model for Germany to follow.

German Anti-American Tariff Discrimination

Germany, he said, must improve her sources of information abroad, because her two chief competitors, the United States and Great Britain, were doing so. "An American chamber of commerce exists in Berlin," he pointed out, "which works excellently. Moreover, the United States has a commercial museum at Philadelphia, with an army of correspondents over the whole world. Half the United States business houses, like shoe stores and others, are springing up in our cities like mushrooms. Germany must, in all friendliness and amiability toward the United States, shape tariff laws on the American pattern."

"ONE OF THE MOST PRESSING QUESTIONS engaging the attention of the cotton world to-day is the development of the resources of the Southern cotton belt," said President Herbert E. Walmsley in his annual address to the members of the New England Cotton Manufacturers' Association.

Greater Cotton Supply Needed

Mr. Walmsley maintained that it was essential to the interests of the United States as a producer, manufacturer, and exporter of cotton, that the supply from our fields should be increased and its cost reduced, so as to retain an enormous source of wealth to the country. He expressed the belief that the trade would never be free from "unlawful high prices, speculation, and unsatisfactory and harmful fluctuations, until there is ample supply of the raw material."

OVER ALL THE WORLD the inventive genius of the Yankee has become proverbial, while the Connecticut Yankee easily bears away the laurels. A glance through the Patent Office records reveals the fact that during the last twenty years Connecticut has stood at the head of all the states in inventiveness, with the exception of four separate years when it ranked second on the list.

Connecticut the Home of Inventions

There is scarcely an object in common use about the home that did not have its origin in the "Nutmeg State." The hinges and locks on the doors, the clock on the mantel, the sewing machine in the

workroom, the silverware on the table, your gun, your bicycle or automobile, your piano and piano-player, besides many such simple articles as kitchen hardware, axes, nails, knives and forks, needles, pins, and chains—all can be traced directly to Connecticut, as well as the letter-box on the corner, the typewriter in use in the office, the ship in the harbor, and the railroad train in which you ride to business. Should you find anything which does not seem to bear the stamp of Connecticut, upon investigation you will probably discover that the machinery for making it, or for the first shaping of raw material, came from that state.

A Steel Diving Cage

WORDEN SMITH of Milwaukee, Wisconsin, has invented a steel diving cage which is a marvel. He was recently successful in locating the British steel ship *Andelana,* which turned turtle and sank in fifty fathoms five years ago.

Mr. Smith descended in his cage, and found the *Andelana* lying on her side and partly covered with mud. Owing to the great depth, several attempts to raise the vessel have failed, divers finding it almost impossible to work there, and one diver having lost his life. Smith's feat was the wonder of marine circles. There is room enough for two men to work inside the diving cage. It has small windows of heavy glass; and on the outside are arm-like contrivances in the shape of grappling hooks and bars, which are manipulated by the men inside.

Scientific Choice of Athletics

ACCORDING TO EXPERIMENTS by Dr. Philip B. Hawk, demonstrator in physiological chemistry at the University of Pennsylvania, scientists will soon be able to tell what branches of athletic exercise are most conducive to a healthy body.

Dr. Hawk directed his investigations toward the blood analysis of representative athletes at the University, examining the number of corpuscles before and after various forms of sport had been practiced. The result of this examination shows an enormous increase in corpuscles immediately after exercising. The percentage of increase in the most interesting of these experiments was as follows:

100-yard dash	24.8 per cent
120-yard hurdles	21.5 per cent
Half-mile run	8.8 per cent
Broad jump (six jumps)	15.0 per cent

The influence of swimming on the corpuscles is most marked, the greatest increase being noticed in a three-minute game of water polo. In this case the average increase was 104.4 per cent, proving swimming to be the most vigorous of the sports considered.

A New "Peril"

MANY PEOPLE consider Russia as a country of barbarians, clinging to ancient superstitions which admit of no innovations or improvements in general conditions. The fallacy of such an idea, in spite of the recognized tendency to political and commercial conservatism, is shown graphically by the actual developments along all industrial lines. That tremendous undertaking, the Trans-Siberian Railway, is known, at least by name, to everybody; but few appreciate its full significance as a factor in future industrial developments in the Far East. The activity in electrical construction also points a finger of warning to other nations that they may expect to find in the vast dominions that acknowledge the rule of the Czar a formidable competitor for the world's commercial and industrial supremacy.

In St. Petersburg and Moscow, the two most important cities of the Empire, the increase in consumption of electrical current during the last year was remarkable, and, although most of the electrical plants are owned by foreign capitalists, it is stipulated, in the majority of contracts, that all material must be of Russian manufacture. In St. Petersburg, the capital city, the total output of current for 1901 was 4,829 K. W.; this, in 1902, was increased to 5,055 K. W., consumed by 2,383 subscribers, as against 2,063 subscribers for the year before. In K. W.-hours the increase was from 6,400,000 to 6,810,000, an increase of about 7 per cent. In Moscow an increase of 25 per cent in the output of current was shown, the figures being 6,075 K. W. in 1901, and 7,074 K. W. in 1902, while the subscribers increased from 2,038 to 2,629 during the year. At the same time great improvements in installation were made. This points to a rapid development of mechanical skill in both the manu-

facture and the operation of electrical machinery. It is impossible that this increased efficiency should be caused entirely by foreign talent, and the only conclusion that can be drawn is that technical education is becoming an important feature of this noticeable activity.

The Russian Government is to be asked by the municipal authorities of Odessa for permission to change the entire system of street railways from horse propulsion to electric. The municipal government of St. Petersburg also has recently been considering a proposition to install electric motive power on all the street railways where the horse is now used. The plans for this change have already been approved by the Minister of the Interior. It is expected that the lines will be extended to Sosnooka, where the new Polytechnic Institute is situated. At least 500 motor cars are to be provided, which will probably be supplied by the Westinghouse Company. All construction work, however, is to be carried on by Russian workmen, and all material used in the changes is to be manufactured within the Empire. As at Odessa, there is to be no interruption of operations on the present lines of street cars. This points to a condition of skill in management that compares favorably with the best American practice. In New York and Washington, when the change was made to electric power, there was no delay in traffic; but it must be remembered that a cable system had been in operation before and that there was no changing of rails and no digging of conduits to be done.

An electric railway is proposed between Warsaw and Lodz, to be built of Russian material. Mr. Drosdof, an electrical engineer of Chicago, is now looking after the plans and making out the specifications. There are few obstacles in construction, as the ground is almost level and it will be possible to build a practically straight line between the two cities.

These various street-railway projects show that Russia is far from backward in the application of the latest technical experience, and have a deep significance as showing that other nations will have to look to their laurels. Inventive genius, it is true, has yet to shine among the Muscovites, but the demonstrated adaptability of the race may be considered a forerunner of original work.

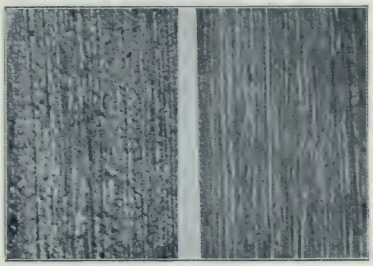
Sublimed White Lead

WHY DO THEY NOT make white lead by the same process used to make white zinc—sublime it with fire and catch it in bags? is the question which presented itself so continually to the mind of Mr. E. O. Bartlett, that, as a result, we have to-day "Sublimed White Lead," which has a remarkable power of resisting weather corrosion.

The plant for the production of this pigment was built at Joplin, Missouri, because that city is at the heart of the richest lead mining district in the world, and because the ores of Southwestern Missouri are almost free from other metals that have to be removed before an ore can be used in the production of white lead.

The process of manufacture is briefly as follows:

The mineral, after being taken from the mine, is finely crushed, washed, and separated, by a gravity process known as "jigging," from accompanying rock and other minerals. In



A B

CONTRASTED WEATHER EFFECTS ON WHITE LEAD PAINT. A, ORDINARY WHITE LEAD. B, SUBLIMED WHITE LEAD. THREE YEARS' EXPOSURE IN EACH CASE.

this purified condition it is delivered to the works, where it is again crushed, sized, and inspected.

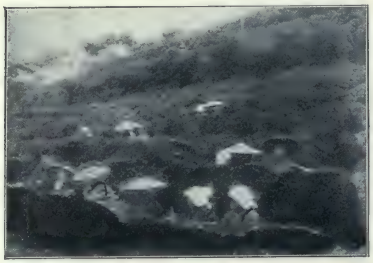
The ore thus prepared is charged, with proper carbon fuel, into patent furnaces of different types specially constructed for the different stages of the process. In the last stage the charge is subjected to a heat sufficiently intense to vaporize the lead contents, with enough air to oxidize it into a basic sulphate of lead.

Powerful suction fans carry the vapors of volatilization through a long series of sheet-iron pipes or flues, up around and through "goose necks," the oxidation being completed during the progress, until the cooled and condensed white vapors of lead oxysulphate are finally collected in condensers which allow the gases of combustion to escape through their meshes. These condensers or collectors are in the form of long bags, hung perpendicularly in a large building, known as the "bag house."

Sublimed white lead is chemically a basic sulphate of lead. Analysis shows it to contain both the sulphate and the monoxide of lead; but the two substances are united into a single chemical compound, inseparable by the ordinary methods of analysis. It is claimed to be an article "permanent in substance and unchangeable in color;" an article that is "unaffected by organic acid, by sulphurous or other gases," and is "non-poisonous."

Manufacture of Japanese Paper

One of the largest advertising firms in the country says of the imitations of its products, "They lack the peculiar and remarkable qualities of the genuine." There are few things to which this statement could more properly apply than to Japanese paper. Natural conditions prevent its perfect preparation elsewhere than in Japan; and in the attempts to use shorter, cheaper methods, much of the quality for which Japanese paper is best known is lost.



In a Tea Garden, Ceylon. A Typical Hillside Scene in the "Pearl of the Indies."

The native method is to soak and beat the tissue much as the ancient Egyptians soaked and beat flax in preparing linen. In this way the cells are neither cut nor destroyed, as is the case in the use of machinery. The fibers are first softened in water, and then beaten with mallets made for the purpose. These mallets are grooved longitudinally, presenting a corrugated surface which, while separating the fibers, tends at the same time to change the relative position of each particle of pulp.

There are several plants furnishing fiber for paper manufacture, but the *kodzo* is a typical one. The sprouts each year are stripped, and are cut into three-foot lengths. By soaking a number of days in water, preferably water which is continually changing, the bark of the sprouts is softened; it is then boiled in water containing wood-ashes, or lye. The pounding is next carried on, until, with the aid of more water, the material becomes a thick, pulpy mass. After a thorough treatment, this pulp is mixed with a cement made of roots, and is rubbed into sheets.

A sieve of bamboo fibers is used for this purpose, the pulp being removed from the wetted mass, drained, and partly dried. By flattening out on a plank and rolling, sheets are formed, which, when thoroughly dried in the sun, can easily be removed.

To the Japanese this paper is well-nigh indispensable. It is used largely for windows, giving a light somewhat similar to that of ground glass, but more highly diffused, softer, and more restful. In the arts it finds many uses, such as the foundation for "cypress gold," that beautiful thread which gives the ancient silks and brocades their unsurpassed richness. Sheets of Japanese paper are covered with gold leaf on one side, and then cut into narrow strips. These are wound about a thread of silk or linen, with the gold face out, and produce a thread having the luster and lasting qualities of pure gold, proportionate to the quality of the gold leaf used.

The wonderful drawings of Hokusai and his companions would never have been preserved for us, had it not been for the lasting qualities of the paper which they used. Japanese paper has an absorptive quality impossible to obtain in other fibers. It thus enables a free use of the brush and permits of a fineness of line hardly attainable on ordinary paper. Indeed, the use of the brush in Japan for writing is directly due to the quality of paper, as the harder utensils of the western nations do not allow of the individuality of expression that is possible with the brush.

Sorting the Leaves. One of the Preliminary Steps in the Process of Preparing the Tea for Market.

THE CULTURE OF TEA is Ceylon's one great industry; and a visit to the fields, crowded with native pickers, with their queer wicker baskets, is well worth the tourist's while. When the baskets are filled or the field is picked clean of young leaves, the tea pickers turn in their crop to be weighed and credited to them, and by a good day's work these women make as much as eight or ten cents a day.

Tea Culture in Ceylon

The tea leaves are carried to the factory, a two-story building with a tall stovepipe and many windows. Any large leaf or twig is sorted out, the leaves are spread on tiers of shelves or trays on the upper floor and left to wilt over night. Twelve or eighteen hours are required to wilt the leaf until it can be put in the roller that the cells of the leaves may be broken, and the tannic juices freed, ready to be eliminated by the next process of fermenting. The moist, withered leaves, which have been rolled and crushed into no semblance of a green leaf, are spread again on trays and covered in the higher temperature until by fermentation they have turned to a bright reddish copper color.

This Ceylon black tea has an advantage over Chinese black tea, which it aimed to supplant and has so largely supplanted in English markets, in that it is touched by the hand of the tea picker only in the field. Every other process is by automatic machines. In China the tea is rolled by hand, fermented in a corner of each small tea farmer's house, and brought to market in any sort of paper bags and old boxes, to be sorted and sifted and refired by the European exporters.

The Chinese names for the different grades of tea are maintained in Ceylon, and from the silvery, unopened leaf bud or "pekoe," the quality descends to "orange pekoe," the just opened yellow leaf, to "Souchong" and "Congou," as the third and fourth leaves on the twig are known. The most flavor is contained in the silvery pekoe or bud and in the young orange pekoe leaf; and when these are sifted and sorted out by themselves, they make a tea of an incredible value like those few pounds of fine pekoe at the Chicago World's Fair valued at £35, or $175 gold, for each pound.

The best broken pekoe sold at the Kiosque and at other tea rooms in Colombo is sold for one rupee—33 cents gold—a pound; and if one orders directly from an estate factory, he can get a first quality tea for table use for a little less.

The tea dust is not made into bricks in Ceylon, but is sold as dust; and much of

WEIGHING TEA.

it goes to Russia, with which country Ceylon has a large tea trade. Shipments for Siberia have for some months past been going direct to Dalny, but recent events have turned the whole Russian trade again to Odessa, for so long the great tea market of that empire.—ELIZA SCIDMORE in *Chicago Daily News.*

THE CONSULAR REPORTS for February contain an interesting communication from United States Consul Bardel at Bamberg, Germany, in which he says that a state institution for loaning money, called the Norwegian Workingmen's Bank, was opened in Norway on October 1, 1903. The object of this bank is to better the condition of the working classes by granting them loans on easy terms, and thus enabling them to secure land and homes for themselves.

Bank for Workingmen in Norway

The law provides loans for the purchase of workingmen's homesteads—small portions of land of at least 1¼ acres and not more than 5 acres—which must either be cultivated or suitable for cultivation, and must not exceed the tax value of $804 for land and home or $536 for the land alone. Provision is also made for the erection, completion, or purchase of houses on loans, these homes to be occu-

pied by not more than two families, with ground not larger in area than 1¼ acres and having a taxed valuation of $1,340 in cities and $804 in the country. Such loans may be obtained by needy Norwegian subjects, or by communities in the country for the purchase and cultivation of land to be divided up for workingmen's homesteads.

A working committee is to be appointed in each community, and its members are obliged to certify that in their judgment the applicant for the loan understands agriculture sufficiently to cultivate the land; otherwise the loan is to be withheld. The members of the committee are also expected to give advice to citizens wishing to make investments, and they are to act as agents between the bank and the applicants for loans. The committees of the respective communities are made responsible for all loans to private individuals and also to associations. The loans must not exceed nine-tenths of the taxed valuation of the property. The interest charged for loans on land is 3½ per cent, and on houses 4 per cent. The payment must be completed in forty-two years in the case of land loans, and in twenty-eight years in the case of house loans. The debt may be reduced in less time if the borrower desires; but if he lapses in his payments, the rest of the loan still due matures and may be collected by force. The plan will thus tend to promote thrift.

Dinner-Pail Philosophy

¶ Success is the child of daring.

¶ A lie travels by wire; the truth by mail.

¶ Yesterday's neglect is to-day's worry.

¶ The best prophet of the future is the past.

¶ The man who snores should be rapped in slumber.

¶ Circumstances do not make men, they discover them.

¶ People who talk too much don't realize it until the next day.

¶ A promising young man is in great demand among his creditors.

¶ To know others, study yourself; to know yourself, study others.

¶ Whenever you have to stop to think whether a thing is right or wrong, you may be pretty sure it is wrong.

¶ We all have strength enough to endure the misfortunes that come to others.

¶ The man who trusts to luck for his happiness will be in luck when he gets it.

¶ There is no use working yourself to death in order to make a living.

¶ Every man should keep a fair-sized cemetery in which to bury his faults.

¶ Some men are so stingy that they won't even laugh at their own expense.

¶ Men who never had any advantages in youth are the quickest to take them when older.

¶ It is surprising how much trouble some people can stand before it gets to them.

¶ A man who repeats everything he hears, after a while doesn't hear anything worth repeating.

The Making of a Captain of Industry

Being Chapters from the Early Life of John Botts, now President of the International Air Engine Company

The Lesson of Concentration

By HENRY M. HYDE

Editorial Writer on the *Chicago Tribune*

IT was a black, red-bellied mud turtle that taught me the great lesson of concentration. I didn't call it that when I learned the lesson, but that will do to describe it.

I went swimming one hot August afternoon, down at the old swimming hole. On the old yellow stone that stuck up at one corner of the pool, I saw a small mud turtle, about the size of a silver half-dollar, lying in the sun. I crept up and caught him.

I took my prize home, and Mother gave me a big tin wash-basin to keep him in. I filled the basin about a quarter full of water, and put some stones in the middle, on which the turtle could climb up and bask when he got tired of swimming about in the water. Then I caught some flies, and threw them, so crippled that they could not get away, onto the surface of the water.

From the top of the water the basin sloped up in a sharp curve for at least two inches. The surface of the tin was smooth and slippery so that it seemed perfectly certain that the turtle had not the slightest chance of escaping.

The moment I put that turtle into the water he started for the edge of the basin. When he struck the tin with his nose, he tried to raise himself up in the water and crawl up and over the top to liberty. But, just as I had foreseen, the tin was so smooth and slippery that his little claws, sharp though they were, could get no hold on it. After painfully and laboriously forcing himself up half an inch or so from the surface of the water, his feet would slip and down he would go again into the depths. Time after time the little fellow tried to climb the impossible tin sides of the basin, but as often slipped back again into the water, frequently turning half over as he fell.

I got some fresh flies, and dropped them right in front of the turtle's nose. But he didn't seem to want any flies; they were no temptation at all. He brushed them aside with his flippers, and kept trying and trying to climb the slippery basin. I picked the turtle up, and gently laid him on top of the stones in the center of the water. I thought he certainly needed a little rest. But he plainly didn't want any rest. The moment I let go of his shell, he climbed down from the rocks and swam across again to where the water lapped against the tin sides of the basin.

I noticed, too, that the turtle didn't keep still in one place, trying time after time to climb up at the same spot. He was all the time swimming, as well as trying to climb, and within half an hour had completed the circuit of the basin and had apparently tried every inch of the sides for a possible foothold without success.

Then I thought: "He will certainly make up his mind that he has been attempting the impossible, and will swim over and take a rest." But he didn't. He started on another circuit of the basin without a second's delay.

I had been watching the little cuss for more than an hour when Mother called me to come and fill the wood-box. Then father came in from town, and I helped

him unhitch the horses and bed them down for the night. When we walked up to the back porch I pointed out the basin, and called his attention to the turtle, which was still trying vainly to mount its sides.

"That turtle has been trying to climb out of there for a couple of hours," I said. "Every time he tries, he slips back again."

"That turtle knows what he wants most," said Father, "and he's just simply bound to git it before he quits."

Well, Sir, before I went to bed, I tried to tempt that turtle with little pieces of fresh beef and some more flies, but he never paid any attention to them. He kept busy all the time swimming around the edge of the water in that basin and trying to climb out of it.

Finally I turned in, saying to myself that by morning my pet would learn how foolish it was to try to climb that slippery tin and would give it up. I was up at 5 o'clock the next morning—my regular time. Nowadays I often have hard work to get to sleep before that time. First thing I did was to run out on the back porch and look for my turtle. The tin basin was sitting just where I had left it. The water and the stones were still in it, but the turtle was gone.

I just sat down and looked blankly at the basin. To save my life I couldn't figure out how it was possible for the little thing to get up the steep tin sides. But he was certainly gone. All the flies and little scraps of meat were still in the basin. The turtle had not stopped to bother with them. It had kept straight after the one thing it wanted most until it finally got it. How, was to me a mystery.

I thought a good deal about that turtle in after years. You might think the lesson it taught was that of perseverance. But perseverance is an effect and not a cause. It was persevering because it wanted to get out of that basin more than it wanted anything else. It didn't stop to eat flies, or to rest on the stones, because there was always one thing else which loomed so much larger in its eyes.

For a man to win success is a more complicated matter than for a mud turtle to get out of a basin—but the same general principles are involved. The reason why more men do not succeed is because they have no definite aim in life—because there is no one thing they want more than anything or everything else. Once a man is filled with the idea that there is something he wants so badly that he must have it, I firmly believe that he is almost certain to get it sooner or later—bar circumstances which are beyond human control.

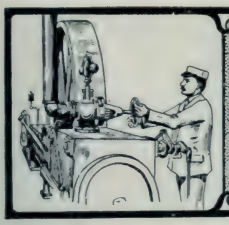
When he starts in, the job he has undertaken is pretty likely to look impossible, at least to everybody but himself. As he goes along he will find plenty of chances to sit down and rest, and to stop and eat and drink, or to enjoy himself in some other way. But if he really wants what he has started after, he'll keep after it in the face of all kinds of temptations.

At the end, people will wake up—just as I did—and be terribly surprised to find that he has accomplished it. And nobody will be able to see just how he was able to do it. That is the reason why it is so hard—really impossible—to give the secrets of the success of any successful man. Every successful man is a mystery to everybody else.

Some months after my turtle disappeared, Mother told me one night that she was probably responsible for that turtle's escape.

"I saw the poor, little thing trying so hard to get out of that basin," she said, "and I couldn't help feeling sorry for him. He was working so hard, and he kept slipping back every time he got started up. So I put a little stone into the water at the side of the basin, so that he could rest himself on that. I really had no idea it would enable him to get away. But I suppose it did."

That's the way it works among men, too. Once a fellow demonstrates that he is simply determined to get something, other people will go out of their way to help him a little. Determination seems to compel helpfulness. And I fancy you would find in the life of almost every successful man some little stone placed at the edge of the deep water, by somebody who was moved by his struggles to do a little something to make the fight easier for him.



ENGINEERING NOTES

A Severe Fire Test

THE BALTIMORE FIRE was the severest test to which buildings of steel construction have been subjected; and their sound condition afterwards—as to supporting columns, girders, joists, and the structural parts of the floors—thoroughly vindicates the main principles of modern fireproof construction. Every building in the path of the fire that was not of steel construction was leveled to the ground, only a mass of debris being left to give evidence of what once was. Thus it follows that modern fireproof construction will enable a burnt building to stand while others will fall. On the other hand, the inadequacy of steel-frame buildings as at present constructed, was made manifest in the fact that the fire was able to come in at the windows, and everything was burnt entirely out, from basement to cornice, except the steel skeleton. Therefore, as in this case the window openings proved to be the vulnerable points where the fire was admitted, and as no building is strictly "fireproof" so long as it is possible for fire to shoot in at any opening, adequate window protection as well as steel construction is necessary for complete safety.

Railroad Tunnel Piling

THE ABSOLUTE SAFETY of the new North River tunnel of the Pennsylvania Railroad is assured by the system of support adopted, which is to be from the bed rock underlying the silt that envelops the tunnel. Cast-iron piles are to be used, screwed through the sand and mud until rock is reached. These piles will be driven every fifteen feet, directly supporting the lines of track, as this is where the greatest strain will occur.

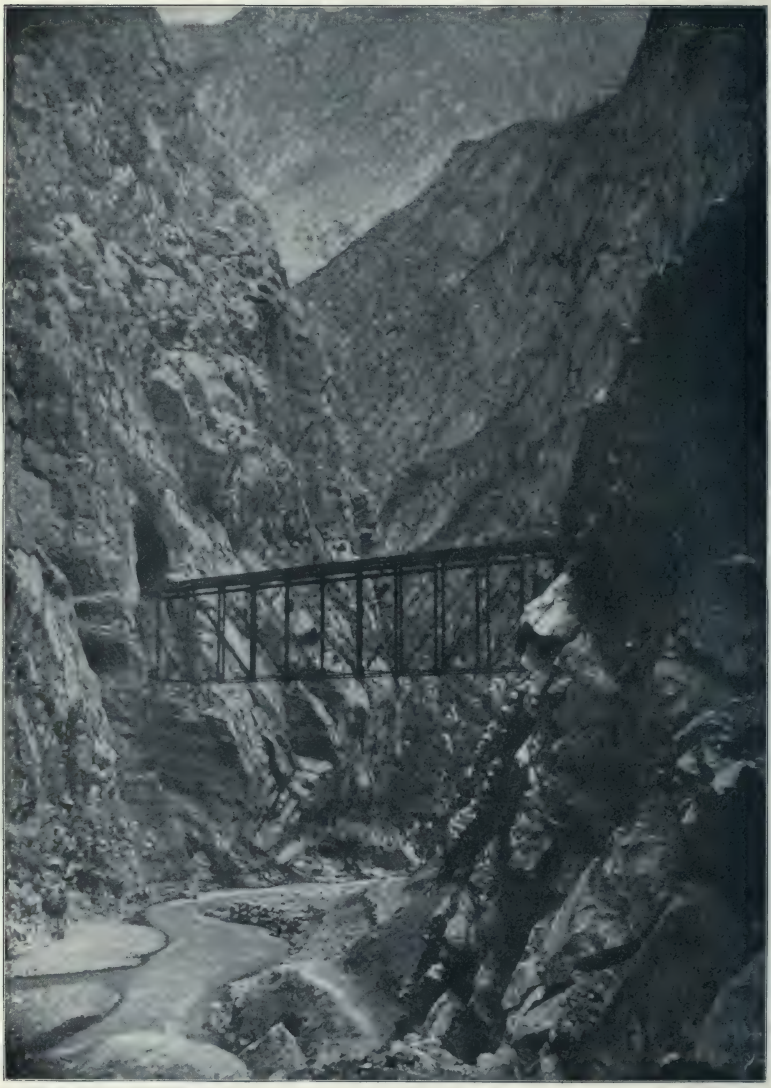
A test was made recently, on the Jersey side of the river, where one of the piles was allowed to support a weight

MARYLAND TRUST BUILDING, BALTIMORE.

This building stood, while non-fireproofed structures collapsed. The three lowest stories were faced with limestone, the upper stories with terra cotta, both materials showing good fire-resisting qualities.

of about 300 tons during six weeks. At the end of that time, there was no appreciable settlement or displacement of the pile.

The method of sinking this test pile was particularly interesting. A hydraulic screwing machine with a stroke of 18 inches was prepared, and was tested to a water pressure of 1,500 pounds per square inch. The bottom of the pile was

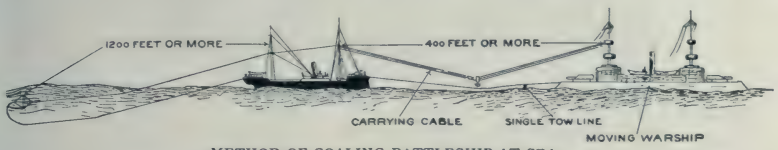


COURTESY OF THE "WORLD'S WORK."

STEEL BRIDGE ON THE OROYA RAILROAD, IN PERU.

A remarkable feat of construction connecting two tunnels in the Andes Mountains.

fitted with a screw about 5 feet in diameter, pitched to 12 inches. A remarkable feature of the experiment was the varying distance the pile was driven at single turns of the screw. One turn sunk the pile 1.2 feet, while another only showed .21 foot. The average was 10.7 inches. During the fortieth revolution, even though subjected to a turning moment of 439,800 foot pounds, the pile refused to move, and the tests for supporting strength were begun. During the first five days there was a subsidence of ¼ inch under a dead load of 500,000 pounds. This was the only noticeable change, except a compression of about 1-250 inch in the pile itself. The entire series of tests lasted for nearly six months, with weight varying from 400,000 pounds to 600,000 pounds. A number of drop tests were also made.



METHOD OF COALING BATTLESHIP AT SEA.

By means of cableways, any masted vessel can take coal at any time from another.

A Marvel of Engineering

TO-DAY there are more than 200,000 miles of railway tracks in the United States, and each ten miles represents an engineering achievement. There does not seem to be any obstacle too great to be overcome by that little body of silent, modest workers we characterize merely as railway builders.

How many of us can call to mind the names of the engineers who projected and built that marvel of engineering, the Oroya Railroad of Peru, which reaches an elevation of more than 15,000 feet above sea-level? The two Americans who constructed this road, Messrs. Meiggs and Thorndike, were considered crazy when they proposed it. It was necessary to carry the roadbed for miles through galleries cut in the solid face of the rock, and the workmen engaged in cutting the galleries were in many cases lowered in cages from the cliffs above. More than sixty tunnels had to be cut in the course of construction, one —the famous Galera tunnel—a mile and a-half long.

It is on this road that the signal achievement of constructing a lofty steel bridge connecting two tunnels was accomplished (see the accompanying illustration). In building this bridge, which spans a crevice 575 feet wide and hundreds of feet deep, it was necessary to lower all material from the top of the cliffs by wire cables.

The whole stupendous task was made possible only by the liberal use of the "V switch," or "switchback." In one instance on the Peruvian railroad it was found necessary to construct a switchback in the side of a mountain, the train heading in on the lower level and backing out through an upper tunnel almost exactly above.—H. H. Lewis in *The World's Work.*

Coaling at Sea

EVER SINCE THE FIRST USE OF STEAM as a motive power, methods of coaling ships at sea have constituted one of the important problems of naval strategy. Broadside coaling has always been dangerous, and the majority of fore-and-aft systems have been so complicated as to be of doubtful value. The Lidgerwood Mfg. Co. of New York have on the market, however, a marine cableway for coaling that seems to have at last satisfactorily solved this difficult problem. One of their installations was on the Russian battleship *Retvizan,* recently brought into prominence—or, rather, put out of action—at Port Arthur.

From a mast on the floating source of coal supply, the cableway is connected to the after mast of the ship to be coaled, in such a manner that if the single towline connecting the two boats becomes

parted, the coaling apparatus is detached from the forward ship without damage and can then be recovered by the collier. This is an important feature, as all liability to excessive strain on the masts of either ship is thus avoided. The diagram shows the method of operation. The sea anchor is necessary to steady the collier. By means of these cableways, battleships can take coal at any time from any masted vessel.

This system has been adopted by the United States Government and is used on a number of the first-class battleships, including the *Illinois* and the *Massachusetts.*

Life Stories of Successful Men

Prince Hilkoff

The Wonderfully Romantic Career of the Russian Minister of Railways—Its Message of Encouragement and Hopefulness

By HENRY M. HYDE

Editorial Writer on the *Chicago Tribune*

BORN on the vast estates of his princely father, with the prestige of four hundred years of nobility behind him, it might be supposed that the career of Prince Hilkoff, the Imperial Russian Minister of Railways and Transportation, would have little of inspiration about it for a poor boy born in a cabin and forced to climb upward by his own unaided efforts.

But when you know that Hilkoff came to the United States as a poor emigrant, and under the name of John Magill entered the Pennsylvania Railroad shops at Philadelphia at a wage of $1 a day; that he worked for several years as a railroad brakeman and engineer, and finally rose—still as John Magill—to be superintendent of a railroad in South America; that he went back to Russia—still under an assumed name—and by sheer merit, as an obscure railroad employee, forced his way upward until he attracted the attention of the Great White Czar, one of whose trusted ministers he has since been—then you begin to realize that what Michael Hilkoff has done in the world is fit to stir the pulse and rouse the ambition of even the most sluggish.

Let no man or woman lose heart or confidence so long as it is possible for a boy born in the Russian purple, and fallen from that dizzy height to the position of a common laborer, to climb again under another name, dignified by no other title than that of a master of his business, to

a place much greater and nearer to the throne than that he originally occupied. If such a thing can be done under the despotic government of Russia, what may not be accomplished in a freer and less caste-ridden country?

It was the emancipation of the serfs by the great Czar Alexander II, grandfather of the present Emperor, which ruined the father of Prince Michael Hilkoff (or, as it is spelled in Russian, Khilkov), and sent the son forth into exile as plain John Magill. It was the thorough knowledge of mechanical and locomotive engineering, acquired in the United States, which made it possible for John Magill to go back to Russia and rise again to a more than princely estate.

Prince Michael Hilkoff looks like a typical down-east Yankee of the old school. In the proper costume, he might easily pose as Uncle Sam himself, for his short white goatee, and his thin, erect figure, with its broad shoulders and long legs and arms, are all in character.

He has paid, in all, three visits to the United States. He came first in 1857. At that time he was a young Russian swell of twenty-one. While a student at the University of St. Petersburg, he had read, in a French translation, the Leatherstocking novels of Fenimore Cooper, and they had first aroused his interest in the wonderful country beyond the ocean. At sixteen he was an officer in the Empress's Guards and something of a favorite at court. Then he persuaded one of his old tutors to accompany him on a visit to the United States. He bore personal letters of introduction to the President of the United States and to other prominent people; and during his stay of several months he saw much of country and was fêted by society. Returning to Russia, he became an official of the Czar's court.

A little later, in 1861, came the emancipation of the serfs, which almost impoverished his father, who demanded that the son leave the service of the Czar. A bitter quarrel followed between father and son, as a result of which Michael Hilkoff renounced his ancestral titles and estates, resigned his office at court, and sailed for America as a common emigrant. He landed at Philadelphia, and his poverty was so great that to secure employment was an immediate necessity.

The first opening that offered was a job attending a bolt-making machine, at wages of $1 a day.

"Your name?" asked the foreman, when he reported for work.

"Mi-kale," began the young Russian slowly, his tongue hesitating when it came to English.

PRINCE HILKOFF, RUSSIAN MINISTER OF RAILWAYS.

"Magill, heh?" snapped back the busy foreman. "Well, what's your first name?"

"John," answered the Prince, deciding on the moment that that would do as well as anything. And so he was fitted with a new name which served him for a good many years.

After a year or two in the machine shops, during which the Prince was studying mechanical engineering, he found a place as brakeman on a freight train. Later he became a locomotive engineer, and he added to the practical knowledge acquired in that way a thorough technical and theoretical knowledge acquired by study after hours.

Presently he was promoted again. This time he became superintendent of a railroad down in South America. There, also, he served several years; when, finally, a longing for his old home in Rus-

sia seized him, which he was not able to resist. He went back, still concealing his princely name and station, and secured a place on one of the Russian railroads. It was an obscure place in an obscure Russian village, but Michael Hilkoff, or John Magill, was not destined to remain in obscurity.

Presently an emergency arose, connected with the movement of trains at the junction point where he was stationed; and in that emergency the technical skill and practical training of Hilkoff showed itself in a way to attract the attention of his immediate superiors, and to win, in the end, even the notice of the Czar himself.

Under orders from headquarters he was promoted as rapidly as he showed capacity for a higher place. Finally, under close questioning, he revealed his identity as a Russian Prince, and as a former officer in the Guard of the Russian Empress. Then followed the story of his romantic and inspiring career as an emigrant to America, and of his work there as a railroad man and student.

The Russian Emperor was delighted to find that the young man who had displayed such great capacity and skill was one of his own subjects. He restored to the master of railroading all the princely estates which he had voluntarily given up years before, and he added other and even more desirable marks of his personal favor. Presently Prince Michael Hilkoff was made Imperial Minister of Railways and Transportation, and became a member of the Cabinet of the Czar.

Hilkoff's masterwork and the monument by which he will be longest remembered, is the great Trans-Siberian railroad, to the construction and equipment of which he, next to the Emperor, lent the greatest impetus.

When it came to ordering the cars and equipment for the Trans-Siberian passenger trains, Hilkoff knew where to turn for ideas. He came back to the United States, and spent some weeks in inspecting the "brag" trains of the great Eastern roads. This was his third visit to this country, and it would be hard indeed to imagine three visits made by the same person under more strongly contrasting circumstances. The first visit was made by a rich and luxurious young Prince, accompanied by a tutor and a servant or two; the second visitor was a poor immigrant, glad to find work at a dollar a day; the third time came again a Prince, but now also one of the most trusted ministers of the Czar, traveling in private cars as the guest of railroad presidents over some of the track where he once rode as an humble employee in the cab of a freight engine.

It is much easier to climb up from a place of comparative obscurity than it is to fall to the bottom from a high round on the ladder, and then to remount it again to the top. That is what Hilkoff has done. He has set an example which should encourage hundreds of men now struggling in discouragement.

Education and Success

AN UNEDUCATED CHILD has one chance in 150,000 of attaining distinction as a factor in the progress of the age.

A common school education increases his chance nearly four times.

A high school education increases the chance of the common school child twenty-three times, giving him eighty-seven times the chance of the uneducated.

A college education increases the chance of the high school boy nine times, giving him 219 times the chance of the common school boy and more than 800 times the chance of the untrained.—*The World's Work.*

Extermination of Fruit-Tree Pests

The Most Effective Methods of Fighting the Destructive Scale which has Given Much Trouble in the West and South

By D. A. WILLEY

PROBABLY the greatest enemy with which the fruit growers of the West and South have to contend, is the insect known as the "scale." There are several varieties of this pest, and unless means are taken for its destruction, it causes much damage to orchards of citrus fruits, frequent instances being known where it has destroyed thousands of trees in one locality.

The damage occasioned by scale insects is of two kinds. The principal injury is the extraction of the juices of the plant. The scale is really a minute pumping machine, continually absorbing the sap from the tree. It consists of a mere sack with a sucking attachment, the latter consisting of a long, slender proboscis or beak, which is thrust deeply into whatever portion of the tree the insect may be resting upon—bark or leaf. While the amount of sap extracted by a single scale insect is very small, when multiplied by millions it greatly depletes the juices of the plant. Very often the amount taken up by the scale is greatly in excess of its own needs, and is excreted in the form of the so-called "honeydew," which accumulates in drops, and which spreads out over the bark or leaf in the form of a sticky liquid. This liquid attracts ants in great numbers, which leads to the impression that the ants are doing the injury instead of being attracted by the honeydew, which they are actively collecting.

The second form of injury caused by scale insects results largely from this honeydew excretion, which not only spreads over the leaves and fruit and prevents the normal respiration of the leaves and the development of the tree, but develops a black fungus in the sweetish liquid that ultimately covers thickly the leaves, twigs, and fruit, thus reducing the marketable value of the products. It often happens, therefore, that the grower is more anxious to avoid the presence of this fungus, which follows the attack by the scale insect, than he is to avoid the injury by the scale itself. Another reason for the extreme injury wrought by the insects, arises from the fact that they are active the whole year round in climates where citrus trees can be grown. The period of their greatest activity and most rapid breeding is during the summer months, and especially from May to August, though they continue with very little check until October or November. In the winter season or rainy season, they are more dormant and, while breeding continues to a greater or less extent, it is at a very much lessened rate.

TENT ENCLOSING TREE, READY FOR ADMINISTERING GAS.

Several methods of fighting these pests have been devised, which are of unusual interest owing to their novelty. One of the most successful plans which has been adopted in California, is known as "gassing." The trees are literally fumigated with a gas composed of cyanide of potassium and sulphuric acid combined with a certain percentage of water. The strength of the gas used varies according

to the size and age of the tree, the fumes for the young trees being the weaker. In applying the gas, the trees are enclosed in tents of suitable sizes. Some of the larger tents are of such dimensions that a tree 35 feet in height can be completely enclosed by means of the apparatus used. Tents of the size shown in the photograph have a diameter of no less than 76 feet. In making them, a center piece of army duck is cut out, 50 feet square, to which are attached four flaps, also of duck. Then around the sheet is sewed a strip of 6-ounce duck a yard in width, to reinforce the material.

For raising and drawing the tent about the tree, a piece of manila rope is sewed around the border of the central piece forming the tent, to which are attached rings. Through these run ropes connected with pulleys that are fastened to the timbers supporting the tent. Usually two stout poles are sufficient to hold the tent erect, one being placed on either side of the tree to be treated. Then, by means of the ropes, the cover is pulled over the top, and encircles the tree until it is completely covered. The gas is placed in an earthen vessel, and set on the ground beneath. The fumes rise so rapidly that the space enclosed is permeated in a few moments, and the operator must act quickly to prevent being overcome by the gas, which is extremely dangerous. The effect of the gas is apparently to smother the young insects and to destroy the eggs which may be exposed. Some varieties of the pest, however, are covered with what naturalists term "armor," and require two or three applications of the gas before they are destroyed.

It is necessary to expose the tree to the fumes for only a few minutes, when the tent can be removed and the operation repeated elsewhere. Thus, with an equipment of twelve or fifteen tents, a group of fifty of the largest-sized peach or orange trees can be easily treated in one night by four or five men. Small trees and nursery stock can be gassed very rapidly. In California as many as 300 have been treated in some instances in twelve hours, with an equipment of forty tents.

METHOD OF DRAWING TENT AROUND TREE.

A Characteristic Orchard Scene in California.

Another method of getting rid of the scale is by the use of steam engines operating force pumps. The engine is mounted upon a truck built specially for the purpose; and the pump which it operates is connected with a reservoir containing a solution used to attack the scale. Such is the power of the pump that it will

force a half-dozen streams through the lines of hose connected with the reservoir, high enough to saturate completely the topmost foliage. In fact this method is quite similar to that employed by firemen to extinguish flame. The apparatus is hauled into the grove to be treated; a man seizes a line of hose, and takes his stand in front of the tree. The engine is started, and as many trees are sprayed as there are nozzles. As fast as one tree has been treated, the hose man turns the jet upon the next, and thus the work continues until the orchard has been covered.

Various solutions are used. One is an emulsion of coal-oil, which is found to be very destructive to the insects. Another compound is made from resin, caustic soda, and fish oil, mixed with water. The reservoirs are large enough to hold at least fifty gallons, while, in some of the principal orchards, tanks containing several barrels are in service.

In addition to the mechanical methods, the fruit growers have an insect ally to fight the scale. This is the ladybird, or ladybug, which was brought to this country from Australia specially for the purpose. It has propagated so rapidly that it is now familiar to nearly every portion

MECHANICAL SPRAYER, FOR TREATING SCALE-INFECTED TREES.

of the United States. The ladybug is the natural enemy of the tree-destroying insects, but is entirely harmless to the trees themselves. It has an appetite for the larvæ of the scale, and has done much to eradicate this evil, especially in Southern California, where it was first used for the purpose.

Engineering as a Profession

An Exposition of the Necessity of Scientific Study

ENGINEERING is a profession, not an art, nor a trade. It is a profession to exactly the same extent as medicine or the sciences or law, and is based upon principles universally true. The knowledge of these principles cannot be acquired by individual experience, nor by lucky discoveries. The experience of thousands of generations, the discoveries of ages and ages, logically arranged by the master minds of the past, constitute to-day these very principles. In order to become proficient these principles must be studied, their knowledge theoretically acquired. A trade can be learned only by actual practice. Skill in blacksmithing or moulding can be acquired only by repeatedly performing the various operations of these trades. Add to this skill the individual conception of the work, the imprint of the worker's personality, and the trade becomes an art. In each case the experience of the individual is essential for the success of the work.

But engineering principles are universally true; you must be conversant with the laws of statics before you can build a bridge or a smokestack; the rules on heat must be studied before you do blast-furnace or steam-engine work. The most skillful application of these principles is a question of experience and talent, as it is also in other professions. An

eye specialist will meet with but little success in treating general diseases; a criminal lawyer cannot draw a modern charter; an electrical engineer will build a poor rolling mill. A further requirement is a mind trained in logic, a mind which is taught to think, to grasp and weigh stipulations, to build up mentally a problem in its entirety, all its details, and conceive all conditions governing it and all which are governed by it. We have a number of men, proficient in their respective fields, who have never visited an engineering school, who substitute, as they proudly claim, practice for theory, who have graduated from the shop. These men ought to be proud for having mastered by individual study, perhaps unconsciously, these very principles which are taught in concise and lucid form in our neighboring schools. Such men are the exception—they rank far above the average both in energy and in mental outfit. And for this same reason I do not like these schools where they make you an engineer while you wait. We are overrun to-day by such men. We want honest schools where the average scholar, not the genius, and not the "chump," may acquire honest knowledge by honest work.

Anyone who does not master these broad theoretical principles is not an engineer. Such a man might be able to copy, reproduce what he has done before, but he cannot accomplish anything higher. Engineering teaches us as the highest goal to apply known principles to new problems, to do creative work. This ability to do creative work we offer to the world as the reason for our existence. As you see this world to-day, it is the work of the engineer. Where is the progress in the trades, where in art? Greek statues are still the choicest gems of art. Stone masonry and wood carving date back 4,000 years. The early Middle Ages produced masterpieces in wrought iron and bronze, which are far beyond the limit of our modern metal butchers. Slow and conservative has been the progress of medicine and law; and even the sciences have made their progress felt more in a physical than a material way. But humanity was awakened—this old earth all at once swung into a new orbit—when, some fifty years ago, engineering was recognized as a profession and studied as such. And it is not the man who invents photographs, or talks to the inhabitants of Mars, but the solid rank and file of well-trained, well-balanced engineers, who have wrought in the last hundred years such miraculous, dumfounding changes that the whole development of mankind up to that time seems incomparably slow.

The evolutionist has taught us that the rapid advancement of man began with the substitution of artificial tools for the natural implements. If this is true, we stand on the threshold of an equally momentous step in the development of the world, dating from the day when the engineer taught man to substitute the powers of nature for his own limited strength.

Engineering is a profession—the youngest one—and in one respect has to learn much from her older sisters. Both the law and medical fraternities watch with jealous eyes over the professional conduct of their members; and while they cannot prevent the existence of "shysters" or quacks, they take prompt and proper measures to demonstrate the characters of such men to the public. This ethical aspect of his station in the world, the engineer seems to have overlooked in his mile-a-minute development. His work, whether as an employee or as counselor of his clients, is a confidential one, requiring not only a mastering of his profession, not only skill in the handling of difficult problems, but a high degree of integrity, which alone can inspire confidence and will lend him that dignity which his profession deserves. The public might be dumfounded by the gigantic, or by the daring of your work; but, hearing that you are an engineer, they will look for the overalls and the oil-can. Let us pledge ourselves to guard our standing, to guard our dignity.—W. Riddle, in *Mining and Scientific Press.*

Theory and Practice

Simple Instances of the Way in which the Pure Theorems of Mathematics Can be Practically Applied in the Working-Out of Shop Problems

By EMIL KVARTZ
A Student of the American School of Correspondence

IN A COURSE on geometry we learn that in a right-angled triangle the area of the figures on the hypothenuse is equal to the sum of the areas of the similar figures on the two other sides. If the figure on the hypothenuse is a square, it is equal to the sum of the squares on the

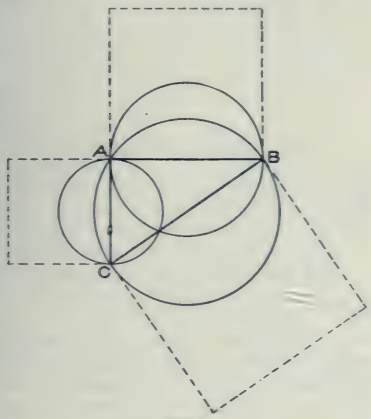


FIG. 1.

two other sides. If the figure on the hypothenuse is a circle, it is equal to the sum of the areas of the circles on the two other sides and so on.

This theory is credited to Pythagoras, a Grecian philosopher who lived about five hundred years before Christ. Let us see if it is out of date, or if we have any use for it in our daily work.

PROBLEM.—Two branch pipes in a piping system are in diameter 3 35-64 inches and 2 15-32 inches respectively. Find the diameter of the main pipe that has the same sectional area as these branch pipes together.

SOLUTION.—From any point, as A (Fig. 1), draw AB (=3 35-64 inches), and draw AC (=2 15-32 inches) perpendicu-

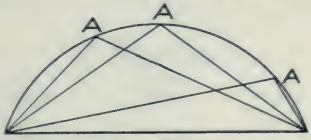


FIG. 2.

lar to AB. Connect the points C and B. Then CB, which in this case measures 4 21-64 inches, is the diameter of the

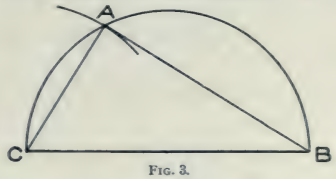


FIG. 3.

main pipe, which is evident from the above theory.

Another lesson in geometry tells us that all angles A in a certain circular segment (Fig. 2) are equal, and that when the segment is a semi-circle these angles are 90°. Now let us see what use we may have for this theory.

PROBLEM.—Suppose, in the above problem, that we had known the main pipe to be 8½ inches in diam. and one of the branch pipes 4⅝ inches in diam. What should be the diameter of the other branch pipe?

SOLUTION.—Draw CB (=8½ inches), and construct a semicircle on CB. Take C as center and 4⅝ inches as radius for an arc intersecting the arc of the semi-circle at a point A. Connect the points A and B. Then AB is the diameter of the other branch pipe, and in this case measures about 7⅛ inches.

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EDITORS { Kempster B. Miller, M. E.
William A. Colledge, D. D.
Alfred S. Johnson, Ph. D.
Carl S. Dow, S. B.

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¶ The want of principle is often the principal want.

¶ All men are born equal, but they soon outgrow it.

¶ A tombstone generally speaks well of the man who is down.

¶ We shall pass this way only once.—Let us make the best of it.

¶ It is cheaper to buy furniture than to carry on a prolonged courtship.

¶ An hour glass is made smallest in the middle to show the waist of time.

¶ Self-confidence is the first step to heroism.—Always show a good front.

¶ Anyone may borrow this magazine, but it takes a gentleman to return it.

¶ The successful man sees things as they are, not as others tell him they are.

¶A man who never makes mistakes loses a great many chances to learn something.

¶ A man who thinks he can't win is sure to be right about it, for he has already lost.

¶ Most of the things you think you know, your neighbors know you only think.

¶ The great man never swaggers, but the man who thinks he is great does nothing else.

¶ The greatness of the average captain of industry is due to the aid he has received from smaller men.

¶ Some people are so mean that they would ask a man to pay rent on the place he occupies in their esteem.

¶ The new woman is one who would exercise the privileges of men without giving up the privileges of women.

¶ The preacher says money does not always bring happiness, but most of us are willing to take chances along with the money.

Give Boys a Chance

RECENT INQUIRY into the facts as to early surroundings, nature of training, and kind of accomplishment of a number of the greater American inventors and engineers, has developed a large amount of interesting matter. Like most other analyses of familiar subjects, the results contain both confirmation and surprise. Four of the examples are inventors and engineers of the highest standing, with names known to every boy who ever built a telegraph line, or blew up the kitchen with home-made hydrogen. The facts show that these men "dabbled" in the sciences when they were boys; that chemistry or physics was their earliest absorbing occupation; that each commercially practiced among his neighbors some homely branch of applied science to furnish funds to forward his absorbing play; and that these boys' parents bore the slops and messes as they could, but did not check and smother the natural bent.

If these are representative examples, the moral is plain that any but the "jelly-fish" boy will try to find a way, and that parents should give them a chance and, if need be, help to make it. Acid-eaten

floors and mottled walls make unsightly houses; stained hands and disrupted clothing make unsightly boys; but sometimes these form the blazed trail to useful manhood. Give the boy a chance.

Accuracy and Success

JOHN ERICSSON, the inventor of the *Monitor,* after perfecting his plans for the invention of the screw propeller, engaged mechanics, and set them to work putting the parts together. The task was nearly completed when the head mechanic approached the inventor and said, "The shaft won't fit." "You are wrong," was the quick reply, "look at your plans." The foreman did, and soon discovered his mistake. Like all other successful engineers, Ericsson had learned the lesson of absolute accuracy. He had such implicit confidence in the correctness of his own work that he did not consider it necessary to discuss the supposed difficulty with the foreman. If a man desires to attain anything in his trade or profession that is really worth attaining, he must be accurate. The only knowledge the world is willing to pay high for is accurate knowledge. Accuracy is the soul of scholarship.

The Tuskegee Idea

IT MAY BE QUESTIONED whether those who are not "on the ground" can appreciate in full measure the conditions of the race problem that is to-day the burdensome heritage of the South. The lack of such complete insight is one of the most fruitful sources of injustice in our judgments of men and motives; and it cannot be said that even in the North has the last remaining trace of the vulture been driven out of the American eagle. There are men in all walks of life, to whom it has never occurred to think of the profound difference that lies between toiling and saving *for the sake of independence and self-respect,* and toiling and saving *for the sake of power and luxury.* The former is a universal birthright, and represents the Tuskegee "idea," so admirably embodied in Principal Washington's administration of the work of the Tuskegee Normal and Industrial Institute—is, in fact, its foundation and topmost stone. The gospel of materialism here gives way to the gospel of industry and thrift; a higher keynote is struck—that of self-denial for the higher ideals; and the so-called "Black Peril" of the Cotton Belt will never be so great as when men have lost sight of this ideal. The following stanzas by Paul Laurence Dunbar, reveal something of the way this school has touched the hearts of the Negro in the South:

"Thy hand we have held up the difficult steps
When painful and slow was the pace;
And onward and upward we've labored with thee
For the glory of God and our race.
The fields smile to greet us, the forests are glad,
The ring of the anvil and hoe
Have a music as thrilling and sweet as a harp,
Which thou taught'st us to hear and to know.

"O Mother Tuskegee, thou shinest to-day,
As a gem in the fairest of lands;
Thou gavest the Heav'n-blessed power to see
The worth of our minds and our hands.
We thank thee, we bless thee, we pray for thee years,
Imploring, with grateful accord,
Full fruit for thy striving, time longer to strive,
Sweet love and true labor's reward."

Some Lessons of the War

WHEN THERE IS A WAR and our country is in it, our attitude should be dictated by patriotism. When there is a war and we are not in it, we probably form our opinions on what we believe to be the truth. In the present conflict, all events seem to show that the Japanese successes have come from the exercise of the virtues of forethought, preparation, discipline, and love of country. We have taught the little people much; but, judging ourselves by our showing in the Spanish War, we cannot claim credit for having taught them by example how to do all that they have done already in caring for troops, making landings, and effecting communications. Whichever contestant wins, we must grant that one side at least seemed to know the strategic game.

Is Money Wasted in Battleships?

FROM THE DAYS OF CAESAR no war has taken place that has not wrecked dozens of cherished military theories, in regard to manœuvering troops, the effectiveness of cavalry, and theories of strategy in general. To-day the value of the modern battleship is challenged. The results of the Russian and Japanese war up to date have raised doubts as to the real fighting efficiency of those monster high-turreted floating fortresses. It is now realized as never before, that the effectiveness of the modern battleship depends so much on the smooth working of its very complex organism, that any injury, not serious in itself, is sufficient to render it unmanageable, and to destroy, for a time at least, the ship's fighting ability. It will be wisdom for our Government to wait a little before spending many more millions, to enable our naval experts and engineers to arrive at some well-grounded conclusion.

Mr. Carnegie and Heroism

THERE HAS BEEN much critical comment concerning the recent proposal of Mr. Carnegie to establish a large fund to provide monetary rewards for the doers of heroic deeds. The objectors have thought that it is not well to run the risk of substituting so ignoble an emotion as hope of financial gain for those of higher ethical value which have served their purpose all these years.

James Shay, a colliery engineer in Pennsylvania, stood at his engine in a burning engine house until he had hoisted to safety the workmen from the mine below. As he staggered from the building, exhausted, burned, and blistered, the roof fell in.

We are wondering whether it occurred to Mr. Shay, under these vivid conditions, to execute any plans for the possible use of such a part of the heroism fund as might be awarded to him. Hardly! True heroism, such as this, cannot be commercialized.

The Educated Man

DOES EDUCATION PAY? The editors of "Who's Who in America" have created no end of discussion by making the plain, bald statement that the men of note in this country are on the whole the men of education, and that success has attended their efforts by reason of their training. The editors of "Who's Who" induced more than 10,000 men "most notable in all departments of usefulness and reputable endeavor," to report their education; and their answers led to the statement that has aroused so much interest. It is doubtless true that circumstances in numberless cases contributed much to the success of these men; but, after all reasonable allowance is made, this fact stands out prominently —that the more education an American boy of this generation has, the greater is his chance of distinction.

Experiment versus Practice

THE SUGGESTION in the article in this number, on the Economy of High-Speed Steel, as to keeping separate the experimental and commercial ends of a manufacturing business, is in general a good one. The manufacturing mechanic, as a rule, has no inborn love of innovations of any sort. A new kind of tool steel, a new method of whatever nature, if left to his decision, is likely to be indifferently tested; and if the first experiment is not an entire success, the whole subject is relegated to oblivion, a possibly valuable improvement is lost, and one more "I told you so" is the result. If such matters, on the other hand, are submitted to a true experimenter, the first failure will be but an inspiration for the next trial; and if there is real merit in the proposed innovation, it will probably come to light. The segregation of the two departments, however, should not be so complete as to prevent a hearty co-operation between the two. The practical shop man should be, and usually is, broad-minded enough to see the value of new methods when once proven. He will be very certain, however, that they *are* proven before he adopts them. The

practical man will in this way, act as a balance wheel to the more enthusiastic, and often more erratic and less practical, experimenter.

Temperature of Factories

MR. TURNER'S STATEMENT that the speeding-up of shafting often quickens the life of the whole shop, is that of a fact often overlooked. This naturally suggests another condition, the effect of which on quantity of output is often of even greater importance. We know of modern factories equipped with every facility for the proper regulation of the temperature during the winter, where the management seems to think that the sole function of the heating plant is to keep things hot. The human animal *en masse* seems to enjoy a moderate degree of roasting; and, as long as no complaint is received, the working rooms are allowed to become so hot as to well nigh stupefy the contented workman. A reform in this direction would not only make the work more lively, but also reduce coal bills and improve the general health of the employees.

The Title "Mechanical Engineer"

A RECENT EDITORIAL in *Power* calls attention to the frequent use of the letters "M. E." by those who never received a degree.

Everyone acknowledges the value of practical experience and will admit that the self-educated engineer may know far more than the young graduate, but it is a far different thing to clothe symbols with a meaning that does not attach to them, or to arrogate a title that is not founded on fact.

Says *Power:*

"There are men who have not a college education who could qualify for a Bachelor's degree so far as the necessary learning is concerned. Would such a man be justified in conferring upon himself the degree and masquerading as a college man because he knew as much or more about the subjects involved than many who wore this title? * * *

"There are many practicing mechanical engineers who have never received the degree, who are more competent than those who have. These men can write 'Mechanical Engineer' after their names when they wish to announce their business, just as another would write 'Architect' or 'Contractor.' This conveys no false impression, and involves no false pretense."

American Woman Wins Degree at Berlin

IT IS INTERESTING TO NOTE that Miss Ina Milroy, of Detroit, Mich., has received a Doctor's degree from the University of Berlin. This is the first time in the history of the University that a woman chemist has earned this degree in Berlin.

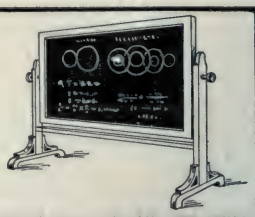
The Bicycle and Advertising

COL. ALBERT A. POPE, of bicycle, automobile, and good-roads fame, has made the statement that bicycling fell off because manufacturers stopped advertising; and that the way to revive it is to resume advertising.

Every business man knows that a market may be created for a meritorious commodity by aggressive advertising; but that the great decline in the use of such a thing as the bicycle, adaptable alike to the pursuits of pleasure, good health, and business, is to be attributed entirely to the lack of advertising, is not quite so apparent. Whether or not Colonel Pope's theory as to the cause of the decline is correct, his remedy is certainly based on sound business principles; and the present bicycle advertising campaign — everywhere apparent — will be watched with interest by the bicycle manufacturer, the lover of the sport, and the business man at large.

CHALK TALKS

by CARL S. DOW.



Number Four.—Levers.

A PLANK supported at each end with a weight or force acting somewhere in the middle, is called a "beam." If the plank is supported in the middle, and the ends are free to move, it is called a "lever." In some cases the lever is supported or pivoted at one end, and the weight and force act at some points in the lever.

The lever is a common device, and is used in almost all kinds of machinery. We see examples of this in lever safety valves, rocker arms, reversing levers, brake levers, etc.

A lever is an inflexible rod which can be moved about some fixed point or line, and to which weights are attached and forces applied.

The point or line about which the lever moves is called the *fulcrum.*

It is customary to call one of the forces the *power,* and the other the *weight.* In the lever safety valve, one force is actually a weight, and the other the steam pressure.

Let us suppose that a plank rests upon a support, and that a boy is placed on each end, as in the game of teeter-totter. One boy is called the weight and the other the power. The portion of a lever between the power and the fulcrum is called the *power arm;* and that between the weight and the fulcrum is called the *weight arm.* On account of the numerous points at which the fulcrum may be placed, care must be taken to consider the arms as extending to the fulcrum.

In case the lever is not horizontal, the power and weight arms are perpendiculars to the lines along which the forces act.

Classes of Levers

Levers are commonly divided into three classes, according to the locations of the fulcrum, power, and weight.

FIRST CLASS: The fulcrum is between the power and the weight, and both power and weight act in the same direction.

SECOND CLASS: The weight is between the power and the fulcrum, and the weight and power act in opposite directions.

THIRD CLASS: The power is between the fulcrum and the weight, and the weight and power act in opposite directions.

Calculations

The calculations of the lever are very simple if one but keeps in mind the fundamental principle. With all three classes of levers the calculations are based on the same principle. In any case,

Weight × weight arm = Power × power arm.

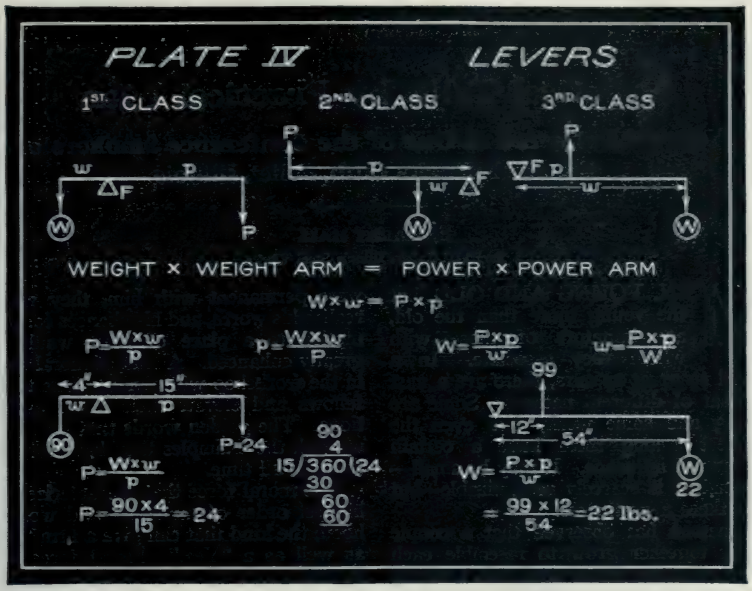
Instead of using these words, let us use the initial letters—

$$W \times w = P \times p.$$

From this equation we get four expressions that cover all cases. (See blackboard.)

Examples

1. Let us first consider an example in which the weight, the weight arm, and



the power arm are known. We wish to find the power. Evidently the first expression should be used, as P is to be found. In this example
W=90 lbs.; w=4 inches; p=15 inches.

$$P = \frac{(90 \times 4)}{(15)} = 24 \text{ pounds}$$

2. In this problem we have given the power, the power arm, and the weight arm. It is required to find the weight. Since the weight is the unknown quantity, we use the third expression as given on the blackboard. In this problem
P=99 lbs.; p= 12 inches; w=54 inches.

$$W = \frac{(90 \times 12)}{(54)} = 22 \text{ pounds.}$$

When we say that the power is to be multiplied by the power arm, we of course mean that the *number* of pounds is multiplied by the *number* of feet or inches, and not that pounds are multiplied by feet.

With the four expressions given, one may, by substituting, solve such problems as have been given. Simply select the formula having the unknown quantity at the left, and then substitute the proper values for the other letters.

In the problems and expressions given above, the lever itself is supposed to have no weight. In case the weight of the lever itself is to be taken into consideration, the problem is a little more difficult, except in the following instance:—If the lever is of the first class, and of uniform section throughout, and the fulcrum is in the middle, the weight of the lever will make no difference in the result.

Practical Talks by Practical Men

Address Delivered at One of the Conference Smokers of the Steel Works Club, Joliet, Illinois

By HARRY HALL
Rod Mill Roller, Illinois Steel Works

MEN, YOUNG AND OLD, but the young more than the old, are imitators of those with whom they associate. In a world so great as ours, there are a vast number of different natures. Some are strong and some weak, but even the weakest among them have a certain amount of influence. It may be small—so small it is scarcely recognizable—but it is there nevertheless.

Emerson has observed that a couple living together grow to resemble each other; and that if they could live together long enough, it would be difficult for us to distinguish between them. An old Spanish proverb runs, "To live with wolves, you learn to howl;" and so it is with a man who possesses a considerable amount of moral force, if you associate with him, his influence on your nature, exercised by that force, is to your advantage, and *vice versa.*

Such a man will gain the confidence of his fellow workmen, so that they are ready to trust him at all times. He may not be popular with them, he may even be disliked, but they in their inmost hearts know that he is a man of honest convictions, that he is to be depended upon in any emergency; and it is to such men that they look for leadership.

If a working man possessing this quality of moral force is fortunate enough to come under the notice of his superiors, his chances for promotion are considerably greater than if he were lacking in moral force. For if this moral force were only an outburst with him once in a while, they would be quick to recognize it; and it is safe to say that in all probability they would not give him another thought; but, on the other hand, if it were permanent with him, they would realize his worth, and his chances for promotion to a place of trust would be greatly enhanced. A man of moral force in the workshop will give the tone to his fellows and elevate their entire aspirations. The golden words that men have uttered, the examples they have set, live through all time.

It is moral force that characterizes the highest order of manhood and womanhood, the kind that can give a firm "No" as well as a "Yea." Moral force is a natural power like light and heat, and all nature co-operates with it; and this force, natural though it is, is no more to be withstood than any other natural force. Men of moral force are the conscience of the community in which they live. An honest man is naturally antagonistic to fraud, truthfulness to lying, the justice-loving man to oppression, and the pure-minded man to vice and iniquity. Such men have and do represent the moral force of the world; and but for the presence of such men in our midst—to antagonize continually that which is depraving—this world would be given up to selfishness and vice. A man as a rule, in my opinion, who is blessed with a pretty good share of moral force, can hardly hope for a great deal of popularity—and certainly not any of the cheap kind which caters to tastes that are not of the best degree—for the very simple reason that his force of character would not allow him to do otherwise than condemn everything but that which he considered worthy. The friends that a man of this stamp would make, we may assume, would be honest and true, would stand for his defense, and would constitute that class of people known as good citizens.

Methods of Moulding

An Explanation of Certain Details of Foundry Work with which the Pattern Maker should be Familiar

By JAMES RITCHEY
Instructor in Woodworking, Armour Institute of Technology

THE PATTERNMAKER should have some knowledge of moulding in order that he may construct his patterns so that they can easily be removed from the sand.

Ordinarily a casting is made in a "flask" consisting of two parts, each containing its complement of sand. The upper part is called the "cope," and the lower part the "nowell" or "drag." The pattern is sometimes made in two pieces

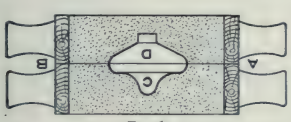


FIG. 1.

that part along the line separating the cope and the drag. Thus, in Fig. 1, the pattern separates with the flask, on the line A B; and when so separated, the cope is turned upside down, and the portion of the pattern C is lifted out. The part D is lifted out of the drag in the same way. In the case of moulding a hollow object, the internal cavity in the casting is formed by means of a dry

FIG. 2.

sand "core," which rests in impressions made in the sand by "core prints" attached to, and forming a part of, the pattern.

Cylinder

To illustrate this, let it be required to cast the hollow cylinder shown in Fig. 2. The wooden pattern necessary to produce this cylinder is shown in Fig. 3, which, as will be seen, represents the cylinder only externally by the part A.

The core prints, one on each end of A,

FIG. 3.

are represented by x and y. These projections form part of the pattern, and make their impressions in the sand with the part A, which alone represents the required cylinder. The core box, in which the sand core is formed, is shown in Fig. 4. The length of the inside of the core box will be the extreme length of the pattern including x and y, and the inside width

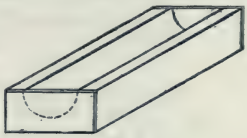


FIG. 4.

will be the exact diameter of the core prints. In this case, the core being a cylinder, only a half core box (Fig. 4) is used. In it are made two semi-cylindrical cores, which, after being dried, are cemented together, thus forming the complete cylindrical core required.

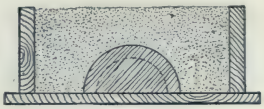


FIG. 5.

To mould this halved or "parted" pattern, as it is called, the upper half of the pattern is laid on the moulding board,

and the drag is turned over it with the bottom side of the drag up and the parting side on the moulding board, as shown in Fig. 5. After being "rammed up," the

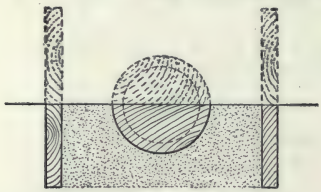


Fig. 6.

drag and moulding board are turned over and the board removed, when the parting of the pattern will be exposed, the half pattern being embedded in the sand.

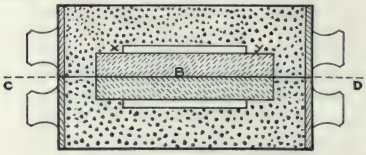


Fig. 7.

The second half of the pattern is now placed in position on the first, and dry "parting sand" is spread over the surface of the wet or "green" sand; the cope is

Fig. 8.

put in position on the drag, as shown in Fig. 6, and rammed up. Upon the cope and the drag being separated, the sand will separate on the line to which the parting sand has been applied, which, as

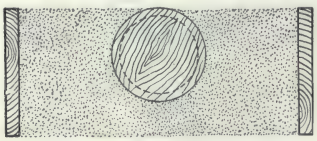


Fig. 9.

will be seen, is the line of parting of the cope and the drag, one-half of the pattern remaining in each.

After the pattern has been removed (one-half from the cope, and the other half from the drag), the completed dry sand core is placed in the moulds made by the core prints *x* and *y*. This core B is shown in position in Fig. 7, and entirely fills the parts of the mould made by *x* and *y*, leaving between itself and the surface of the mould made by A,

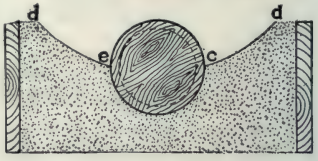


Fig. 10.

room for the metal to be poured which is to form the required cylinder.

In moulding the above cylinder, it is not necessary that the pattern should be parted (made in two halves) as shown in Fig. 3. Patterns for small work, and even for large castings, are often made

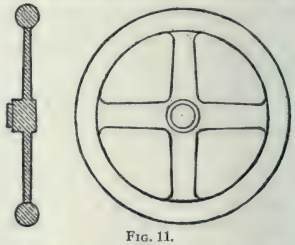


Fig. 11.

in one piece, as shown in Fig. 8. To mould this solid pattern, it is placed on the moulding board with sufficient sand to keep it from rolling; and the drag is inverted over it as before. When the drag has been rammed up, it is turned

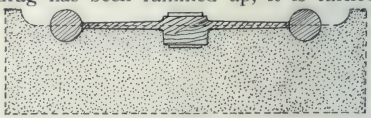


Fig. 12.

over, and will then present the appearance shown in Fig. 9, the entire pattern being embedded in the sand. The sand is now cut away and removed, as shown in Fig. 10, down to the center line of the pattern. The cut sand is smoothed; and, after dry parting sand has been applied to the surface of the wet sand, the cope is placed in position and rammed up as usual.

Upon the cope being removed, the sand will part along the lines *d e* and *c d*, leaving one-half of the entire pattern exposed. The pattern can now be lifted

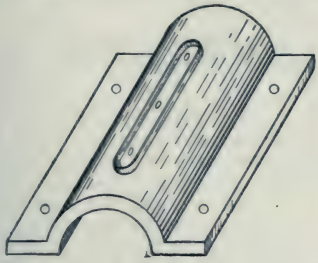


Fig. 13.

out, the core placed in position, and the cope returned to its place on the drag, when it is ready for the pouring, as in Fig. 7.

Fig. 14.

Small Hand Wheel

Another example of a one-piece pattern is the small brass hand wheel shown in Fig. 11. The pattern for this wheel is placed on the moulding board, and the drag inverted over it and rammed up. After the drag has been turned over, the sand is cut away and removed, not only down to the center of the rim, but also to the center line of the four arms, as

Fig. 15.

shown by the dotted lines in Fig. 12. All cut surfaces of the sand are smoothed, parting sand is sprinkled over the parting thus made, and the cope is placed in position and rammed up. When the cope is lifted off, the sand will part half-way down on the arms and rim, allowing the pattern to be taken out with ease.

Journal Box Cap

Still another example in which a single-piece pattern can be used, is shown in the journal-box cap illustrated in Fig. 13. A cross-section of the pattern

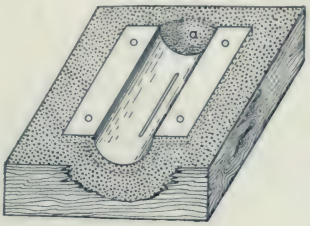


Fig. 16.

through two of the bolt-hole core prints is shown in Fig. 14. The pattern is placed on the moulding board in the inverted drag, and is rammed up as usual.

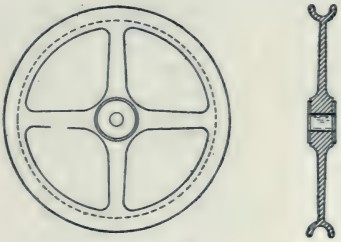


Fig. 17.

When the drag is turned over, the position of the pattern in the sand is as shown in cross-section in Fig. 15. The sand that may have entered the curve

Fig. 18.

c d e is lifted out, and the necessary "draft" is given to the sand at the two ends of the opening *c d e*, as shown at *a*, Fig. 16. The cope is next placed in position; and when this has been rammed up and lifted off, the sand lying in the

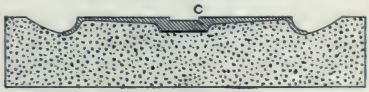


Fig. 19

curve *c d e* will be lifted with it. The pattern is now removed; the bolt-hole cores are placed in position; and the cope is returned to its place on the drag.

In this case the core prints should be in length at least twice the thickness of the metal through which the hole is to be cast; and the length of the cores will be equal to the thickness of the metal, plus the length of the prints.

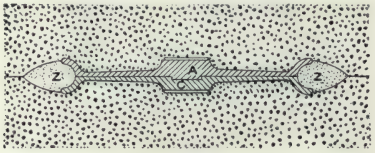


Fig. 20.

Sheave Pulley

In the small sheave pulley, Fig. 17, we have an example of a casting the construction of the pattern for which, so as to make it easily removable from the sand, may give some trouble to the beginner. The pattern is shown in cross-section in Fig. 18, and is moulded in a

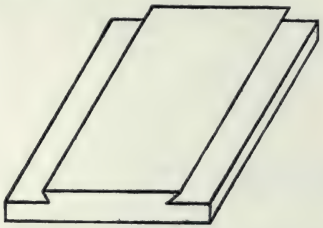


Fig. 21.

two-part flask. At first it would seem impossible to place the pattern in the sand so that either half could be removed when the cope and drag are separated on the parting line of the pattern. This is readily accomplished, however, as follows:

The half pattern C is placed in the inverted drag, with the parting downward on the moulding board, and is rammed up in the usual way. After the drag is turned over, the sand is cut away and removed to the center of the rim edge, as shown in Fig. 19. The cut is carefully smoothed, and parting sand applied to the cut surface. The part A of the pattern is placed in position on C, and is rammed up carefully, the sand being then cut away to the center of the rim edge of A. Parting sand is applied to the new

Fig. 22.

surface, after which the cope is placed in position and rammed up.

When the cope and drag have been separated, the upper half A of the pattern is taken out, and the cope is returned to its place on the drag. The whole flask is now turned over, and the drag lifted off the cope, when the ring of green sand (Z, Fig. 20) will rest on the cope sand, and the part C of the pattern is taken out. We thus have two partings of the sand mould, but only one parting of the flask.

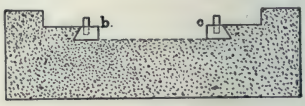
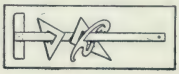


Fig. 23.

Many other examples might be given, as the case of the common two-flange pulley, which, when small, is often moulded in this way.

Patterns with Overhanging Parts

It is frequently the case that parts of the pattern will overhang so that the pattern cannot be removed from the sand in any direction, even if parted. In such cases the overhanging parts are fastened loosely to the main part of the pattern by wires or wooden pins. An example of such a casting is shown in the slide, Fig. 21. A cross-section of the pattern for this slide is shown in Fig. 22, in which the two overhanging parts are held in position by the use of pins. After being rammed up, the part A is removed, leaving the parts *b* and *c* still in their positions in the sand, as in Fig. 23. These may now be carefully moved toward the center of the opening and lifted out.



Armature Windings

An Explanation of the Open-Coil and Closed-Coil Types of Both Drum and Ring Windings

By L. K. SAGER, S. B., LL. B.

Formerly Assistant Inspector, United States Patent Office

THERE are two distinct types of armature windings — the "closed-coil" and the "open-coil."

In the closed-coil winding, all the conductors are interconnected so as to form an endless winding, consisting of two or more branches connected in parallel. In the open-coil winding the conductors are joined in groups, each group containing in series all conductors which have a similar position with reference to the field. The current is supplied to the external circuit only from those groups which are generating the highest E. M. F., all other groups being temporarily cut out of the circuit.

Armature windings may also be divided into "ring" and "drum" windings. In the first, the conductors are wound upon and in the form of a ring; in the second they are wound longitudinally upon a cylinder or drum. Open-coil

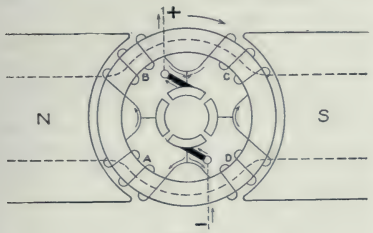


FIG. 1.

windings are used only in special types of machines, such as those for arc lighting; closed-coil windings are used in machines for such common purposes as incandescent lamp lighting, power, and heating.

Closed-Coil Ring Windings

The ring winding is the simplest, and therefore will be first considered.

Figs. 1 and 2 represent a four-coil Gramme or ring winding having a four-part commutator, and consisting of four coils wound about the iron core, with the

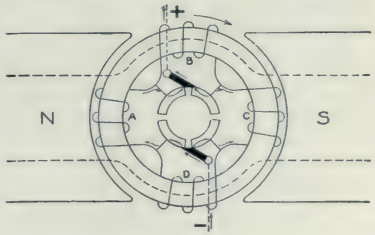


FIG. 2.

junction of the coils connected to the commutator bars. The magnetic lines from the north pole pass to the iron core and then to the south pole, as indicated by the dotted lines, there being no magnetic lines across the space enclosed by the ring. Hence, as the armature rotates, the conductors on the exterior surface of the ring cut across the magnetic lines twice during each revolution, while the conductors within the ring merely serve to connect the outside conductors in series, and are not effective in generating E. M. F. Each coil in Figs. 1 and 2 is made up of three external conductors, and therefore the E. M. F. of each coil will be three times that of a single conductor.

In Fig. 1 coils A and C are shown as having partly entered the magnetic field, and coils B and D about to pass out of

the field. The path of the current is indicated by the arrows, and passes from the external circuit to the lower brush and one bar of the commutator; it then divides, and passes through coils A and B in series on the left, and coils D and C in series on the right; it then unites, passing through the upper commutator bar

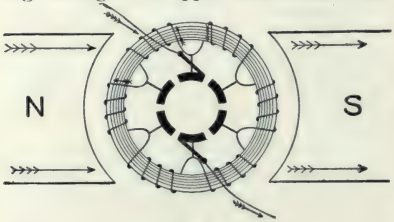


Fig. 3.

and upper brush to the external circuit. As there are two coils in series, the total E. M. F. will be the sum of the E. M. F.'s of the two coils for this position.

Fig. 2 shows the position after the armature has advanced 45° from that shown in Fig. 1. Coils A and C are then generating the maximum E. M. F., and the current passes from the lower brush through coils A and C in parallel to the upper brush. Coils B and D are in what is called the "neutral position," and generate no E. M. F.; in fact, they are temporarily *cut out* of the circuit, the commutator bars and brushes forming direct connections between coils A and C. Coils B and D are said to be "short-circuited;" that is, there is a direct connection of low resistance between the ends of these coils by the commutator bars and brushes, and no current will then pass through the coils.

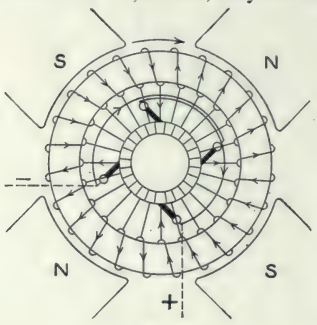


Fig. 4.

Upon further rotation, coils B and D will pass to the other side of the brushes, and they will then generate an E. M. F. in the opposite direction.

Fig. 3 shows a ring-wound armature with six coils; and, as shown, the current divides, passing through the two halves of the winding in parallel. All the coils on one side are in series, and each adds its portion to the total E. M. F.; the greater the number of coils, the less will be the fluctuation in the current. The E. M. F. of each coil varies at different positions; and the E. M. F. generated by some of the coils is increasing, while that of others is decreasing. The total E. M. F., however, remains practically constant when thirty or more coils are used.

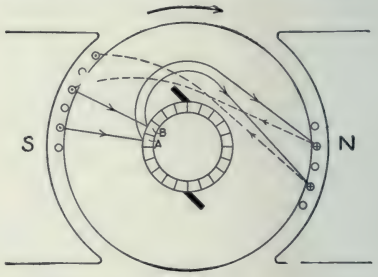


Fig. 5.

Fig. 4 shows a ring winding for a machine with four poles. The winding is the same in form as for a bipolar machine, but the number of brushes and number of circuits through the armature is doubled. Therefore there are two positive brushes and two negative brushes. The two positive brushes are electrically united, and connect with the positive wire of the external circuit; while the two negative brushes are united, and connect with the negative wire of the external circuit. The current divides at each of the negative brushes, passing in parallel through four circuits (two for each brush) to the positive brushes.

For machines with a larger number of poles, there would be a corresponding increase in the number of circuits through the armature.

The number of pairs of brushes may also be correspondingly increased, or

there may be but one pair, since all terminal sections of the same sign (+ or —) can be soldered together.

Closed-Coil Drum Windings

Drum windings are distinguished from ring windings in that all wires of the drum armature are distributed over the outside surface of the core. The winding forms a cage which envelops a cylindrical iron core. In the ring armature, a large portion of the winding merely serves as connecting leads for that part which lies on the exterior of the core. In the drum armature, however, the only conductors serving as connectors are at the ends of the cylinder, and therefore a very different form of winding is necessary.

In the ring winding, adjacent conductors are connected directly in series

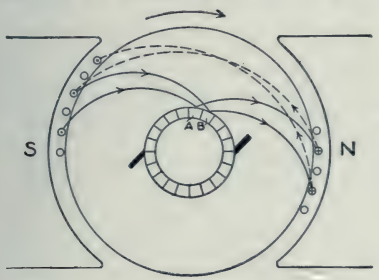


Fig. 6.

with each other by looping around the ring core, but in the drum winding the return portion of the loop must lie on the exterior of the core; and in order that the E. M. F. induced in each part shall aid the other, the return portion must lie under a pole of opposite polarity to that under which the forward portion lies.

The current in passing through the armature from brush to brush, must gradually progress through each turn in series. Fig. 5 illustrates a portion of a drum winding, only two complete turns being shown. The small circles represent end views of conductors on the surface of the armature. The crosses and dots indicate the direction of current, the cross representing the tail of a retreating arrow, and the dot the head of an approaching arrow. The current gradually progresses from bar to bar of the commutator, as indicated by the arrows. The current passes to bar A from a conductor at the left of the core, under the influ-

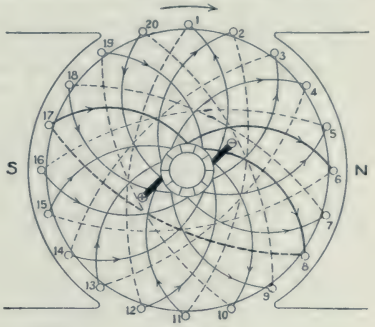


Fig. 7.

ence of the south pole; then by a spiral connector to a conductor under the north pole; thence by a spiral connector at the back end of the core, through a conductor under the south pole, to bar B; then by a spiral connector to a conductor under the north pole, etc. It will be noticed that only the alternate conductors are connected in series; but the intermediate conductors are connected in series with each other to the right-hand half of the commutator.

In order to make all end connectors of the same length and form, the commutator is usually turned 90° in advance

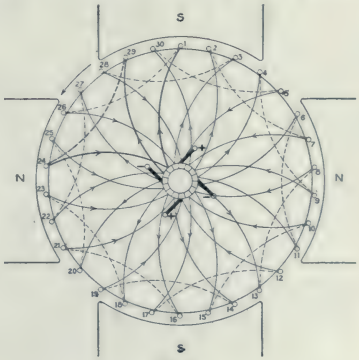


Fig. 8.

of the position shown in Fig. 5, giving an appearance as in Fig. 6. This causes brushes of drum-wound machines to be

opposite the poles instead of between them as in ring-wound machines.

Fig. 7 gives an end view of a complete drum winding in which there are ten complete turns and ten commutator bars. The windings form two circuits in parallel from brush to brush, as may be

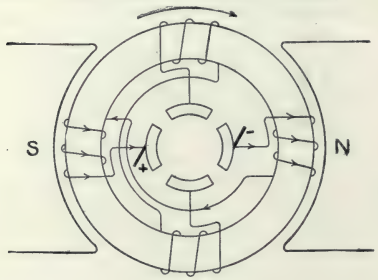


FIG. 9.

seen by tracing out the paths of the current. All parts of the winding are similar to each other; and a portion, called an "element," is made in heavy lines to show clearly the general shape of the turns.

Fig. 8 shows a form of drum winding for a four-pole machine with fifteen turns and fifteen commutator bars. It will be seen from the figure that there are four separate circuits between the brushes, two being in parallel from each brush to the other.

Open-Coil Windings

Open-coil windings are similar to closed-coil, except that there are no end connectors between the commutator bars, each coil being alternately cut in and then out of the circuit. Such a winding of four coils with four commutator bars, is shown in Fig. 9. The opposite coils are connected in series, and each pair of coils alternately make connection with the brushes.

In the foregoing, only the simplest forms of winding of the different classes have been considered, these being illustrated with figures showing a small number of turns. In the actual machine, however, the number of turns is much larger; and there are also a great variety of windings under each type, many of which are equivalent electrically but allow considerable variation in the mechanical construction. The number of poles and the number of brushes used also permit the connecting of the conductors in a variety of ways.

Pump Valves

A Brief Explanation of the Various Forms of Valves Used at the Water End of Pumps

By ARTHUR L. RICE, M. M. E.
Editor, *The Engineer*

PUMP VALVES must be so made that they will open and close quickly and fully with little friction, so that there shall be no obstruction to the passage of the water, yet little leakage of water past the valves after the reversal of motion of the piston and before the valves have seated. Quick opening requires a light valve with slight motion, but quick closing demands either a heavy valve or a spring to hasten its action. In the older forms of pumps, it was the custom to use one large valve with a lift sufficient to give the required passage; the valve was then heavy enough to close of its own weight, but

was clumsy and hard to fit to a seating. In modern practice the required area is divided among several small valves, so that each one is easily and cheaply renewed in case of accident or wear; and quick closing is obtained by the use of springs on the spindles of the valves.

The natural classification of valves is by the motion, and by the method of

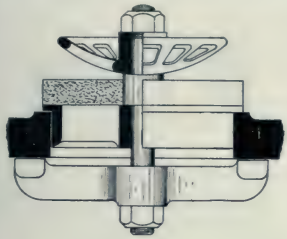


Fig. 1.

securing a tight joint. According to the motion there would be division into "flexible," "hinged," "poppet," and "ball;" according to the seating, into "cushioned" and "ground."

The Flexible Valve

This is the oldest type, and is in some ways the simplest. It is generally made of rubber, as this material gives the greatest flexibility with the best seating. The valve is made as a solid disc, the opening being obtained by the flexibility of the valve itself, and is usually of the style shown in Fig. 1. The seat is made with radial grids to take the pressure of the water, the openings between the bars being made equal to the thickness of the disc; this thickness depends in turn on the diameter of the disc, and is often made as given in the following table:

Diam. of disc. Inches.	Thickness of disc. Inches.	Diam. of hole in center. Inches.
2	$\frac{3}{8}$	$\frac{1}{2}$
$2\frac{1}{2}$	$\frac{7}{16}$	$\frac{1}{2}$
3	$\frac{1}{2}$	$\frac{9}{16}$
$3\frac{1}{2}$	$\frac{5}{8}$	$\frac{11}{16}$
4	$\frac{5}{8}$	$\frac{11}{16}$
$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{13}{16}$
5	$\frac{3}{4}$	$\frac{13}{16}$

The valves of this type most commonly used are the 3-inch and the $4\frac{1}{2}$-inch, as larger sizes are not found durable. The 3-inch is the best for ordinary use. The hole in the center is made 1-16 to $\frac{1}{8}$ inch larger than the spindle, to allow of free motion. To avoid sudden bending of the rubber, the guard is placed so as to give the disc a chance to rise about 3-16 inch. When it has risen so far, it bends around the guard and thus gives a free opening for the passage of the water. The guard should have a diameter equal to that of the disc less twice the thickness of the disc; and the radius of curvature should be equal to the diameter of the disc. This type of valve is not well suited for high pressures, 250 feet head being about the limit for the ordinary style. If, however, there are vanes arranged below the disc so that a rotary motion is given to the valve, it is found that there is no difficulty in keeping the valve tight for heads up to 490 feet. For these pressures, it is not uncommon to use discs of a thickness up to one inch, but only for large sizes. The lap of the valve over the edge of the seat should be from $\frac{1}{4}$ to $\frac{1}{2}$ inch, according to the thickness of the disc and the pressure to be carried.

Leather Valves

Leather valves have been used to some extent in the form of a simple flap fastened at one side and free to rise at the other; this makes the simplest form of

Fig. 2.

hinged valve, and, when weighted with a metal disc on either side, has been much used for small hand pumps. It is not suitable for severe service.

Hinged Valves

The "hinged" valve, as its name implies, is made to swing about a pivot at one side, but should be designed to lift from its seat before it begins to swing. The disc is made of metal, but often with a facing of leather or rubber for low speeds; for high speeds these linings will not stand the wear. The lift should be about $\frac{1}{8}$ to $\frac{1}{4}$ inch before the valve begins to turn about the fulcrum. The angle to which the valve lifts is usually

made 30 degrees, and should never be over 60 degrees, in order to ensure quick opening and closing. The motion is limited by a stop on the seat or on the disc of the valve, as seen in Fig. 2. The hinged valve is slow in action and is not suitable for thick liquors or high pressures. In designing, the area allowed should be as follows:

Piston speed, feet per minute	100	125	150	175	200
Area of waterway, per cent of plunger area	40	50	60	75	100

For higher speeds or for high pressures, it is best to use some form of positively driven valve; and, if such liquors as sewage or syrups are to be handled, the areas indicated by the above table should be increased about 50 per cent.

Poppet Valves

The most common form of valve in use at present is the "poppet," which rises straight up from the seat, and gives a free opening with a small motion. The seat is made either flat or at an angle of 45 degrees, as the designer may choose,

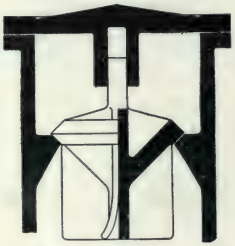


Fig. 3.

the beveled seat being more difficult to construct, but retarding the flow of water less, than the flat seat, which necessitates a double turn in the current. The width of the beat or edge of the seat against which the valve rests, is made ¼ inch for large valves, and 1-16 inch for small ones. The flow of the water through the valves should not be at a higher velocity than 200 feet per minute; and the lift must be so proportioned that the passage by the valve will be as large as the area of the valve opening. A valve with flat seat need not have over ¼ inch lap, even for heavy pressures; but the joint must be carefully made to avoid leakage.

Miter and Flat-Seat Valves

A common form of "miter" valve is shown in Fig. 3; and of "flat-seat," in Fig. 4. The vanes on the bottom of the disc, which keep the valve centered when it rises, are often given an inclination of ½ inch in 6 inches, so that the rush of the water will give the valve a rotary motion, removing all dirt and keeping the

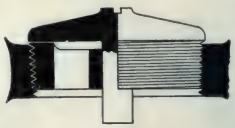


Fig. 4.

wear on the beat even. For the flat-seat valves this is not always possible, as they are closed by a spring, and the friction prevents them from revolving.

In order to give an area by the valve equal to the area of the seat, the lift must be one-quarter the diameter of the seat opening. For heavy pressures this would make too large a lift, as the slip on closing would be excessive; and for this reason the lift is made not over ¼ inch, the number of valves being increased as may be necessary. The seat is usually made separate from the valve deck and screwed into place. When this construction is used, the guide for a valve (if there is one) should be made a part of the seat so that the valve is self-contained. The guides may be in the form of wings on the bottom of the valve disc, a spindle running through a hole in the seat or a spindle projecting upward through the valve, the last being the most common.

The discs may be of metal or of hard rubber. For hot liquids, metal must be used; but for cold liquids, hard rubber or composition is more common in practice, the disc being provided with a metal cap to keep it in shape. The spring used for closing the valve should be parallel rather than conical, as the stress on the latter form comes largely at the small end of the spring, and the wire is likely to break there. A design to be recommended is that of Fig. 5.

Double-Beat Valves

"Double-beat" valves and those with multiple ports are not usually necessary, but are sometimes used for large work.

Ball Valves

Ball valves are often used for low pressures. For these the diameter of the ball is made 1¼ times that of the beat, and a cage is provided so that the ball shall always be kept central. The ball is of gun metal, usually with a rubber casing, or—for cold water—sometimes wholly of rubber. These valves are common in pumps used for mines and oil wells, and often in connection with cup leather packings for the piston. If the water is gritty or has impurities, the valve seat should be raised above the deck so that there will be room for the sand to settle below the seat, as seen in Fig. 6.

In all valves which have metal for both discs and seats, it is important that these

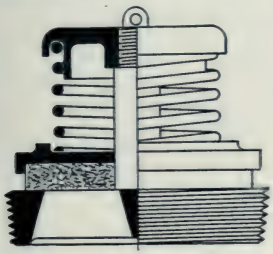


Fig. 5.

should both be of the same material, as otherwise there is likely to be galvanic action, which will cause rapid deterioration. Usually, however, it is better to use the valve with a separate disc of composition, as this avoids all possibility of electrical action, and makes the refacing of the valve unnecessary, the replacing of the old disc by a new one being all that is needed when the valve becomes worn.

For valves which are to be returned by a spring, it is best to use five coils in the spring, and to have the wire of spring brass, of the size given in the following table:

Diameter of valve in inches	2	2½	3	3½	4	4½
No. of wire, B. & S. gauge	12	12	10	10	8	8

In this style, it is well to use for the guiding spindle a stud screwed solidly into the valve seat or made a part of the

Fig. 6.

casting, and to fasten the valve by a nut at the top of the stud, secured by a pin. This is usually better than to use a stud screwed into the valve seat. If the latter is used, it is likely to work loose, and may cause much damage before the trouble is discovered; it is also more difficult to remove when repairing is necessary.

The material for the valves depends on the liquid to be handled. For acids or liquors of that nature, it is best to use wood. Although this is not durable, yet it will last better than any form of metal. For salt, petroleum products, and strong alkalies, gun metal is the best. For all ordinary uses, however, cast iron is good enough; and, if used with composition discs, there will be no trouble from rusting fast, even if the pump is idle for considerable periods.

The Correspondence Student

Extracts from an Address Delivered before the Indiana Teachers' Association at Richmond, Indiana

By FRANK W. GUNSAULUS, D. D.
President Armour Institute of Technology

DURING THE PAST YEAR the Armour Institute of Technology has reached thousands of the most enterprising and courageous young men in this country through the American School. * * *

The man who seizes such opportunities for self-improvement as are offered through these courses, and obtains his instruction papers while he is at work in the shop, engine-room, locomotive cab, or in the field of Civil Engineering, has a school with its equipment and apparatus at his hand.

No little book is more interesting to me than that which contains the grateful words of recognition sent to the American School of Correspondence by young men who have saved what are called "idle moments," devoting such time to study. This work, in many instances, has led young men later on to extend their education at the night school, summer school, or, in some instances, even in the College of Engineering of Armour Institute of Technology.

There are thousands of our most vigorous and our most ambitious young Americans who have the making of great engineers in them, but who, owing to circumstances, are unable to attend a resident school. The technical school, however, can take many of its privileges to them in a most effective way. Our experience leads us to believe that the independence and efficiency of the American mechanic will be largely increased through correspondence instruction, under the direction and guidance of men who have the facilities of a high-grade college of engineering at their command.

In Lighter Vein

"A CARPENTER in a Scotch village, to oblige the local undertaker, who was ill, went to screw down a coffin lid. The sick man's wife gave him full and particular instructions respecting the task. "Well," she asked when he returned, "hoo did ye get on?" "Fine," was the reply. "But there was hauf a sovereign in the corp's hand. What was that for?" "Oh," said the lady, "that's a custom some folks hae. He's supposed to gie that to the ferryman who rows him o'er the river o'death." "Do ye tell that? It's a queer warld. But I'm sayin', Misses." "Yes?" "I'm feared your chap will hae to swim."

Noon Hour Talks

The Divine Insanity of Noble Minds

RALPH WALDO EMERSON said, "Every great and commanding movement in the annals of the world is the triumph of enthusiasm." Is that your opinion? Or are you one of those individuals who are afraid to show any deep enthusiasm in case your friends laugh at you? In 1856, James J. Hill borrowed the money to pay his way from his father's farm in Canada to St. Paul, Minnesota. To-day this same James J. Hill is one of the greatest railroad men in the United States. What led to this success?—Enthusiasm. The zeal with which young Hill engaged in any project, overcame obstacles, won men to his way of thinking, and instilled faith and courage into his associates. Over and over again society has watched some worker toiling and sacrificing for the development of a seemingly indefinite idea that he himself could not clearly express in language. His fellows have watched him and laughed in their sleeves. The worldly wise have called him a fool or a crank; when, lo! a day came when this man in rags gave to the world the golden coin his brain and hand had minted, and soon Kings and Presidents were glad to welcome him to their homes.

Invention Rich in Names

The history of science, invention, and commerce is rich in the names of men and women whose lives are excellent examples of the truth of Lowell's words—that the "conclusive evidence of a man's sincerity is that he gives himself for a principle." Words, money, all things else, are comparatively easy to give away; but when a man makes a gift of his daily life, it is plain that the truth, whatever it may be, has taken possession of him. Time will not permit to name the men and women in every department of life who, amid obstacles sufficient to daunt the stoutest heart, struggled on, year after year, uncomplaining, cheerful, until the ambition of their souls was realized in steel or stone. George Stephenson, the coal miner, labored early and late for fifteen years to perfect his locomotive. James Watt spent twenty years on his condensing engine. Goodyear of Philadelphia, deep in debt, and selling his clothes for food, worked twelve hours a day for five years on his experiments with rubber. I can think of no other power that held these men to their tasks, or kept them from dying of despair, but their enthusiastic faith in the successful materialization of their ambitions.

Enthusiasm and Success

Without a deep, moving purpose in life, no person can accomplish a really great thing. He may be brilliant and popular; but unless his brain and hand are backed by a genuine enthusiasm, he will fall below a man of less ability but more zeal. When a famous actor was performing in Boston, he sent for the manager at the end of the first act and said, "I cannot go on with this play if the audience keeps its hands in its pockets. Such an audience would extinguish a burning mountain." The manager told a

few friends in the front of the house and when the curtain went up on the second act, the actor received the applause his artistic endeavor deserved. The awakened enthusiasm of the audience inspired the actor and redoubled the excellence of the evening's enjoyment.

Youth and age stand equally in need of this spirit of enthusiasm. It sweetens life, makes the rough places smooth, and gives color and tone to character. Enthusiastic old age is one of the most helpful sights in the world. Because the course of nature necessitates the aging of the body as we grow in years, that is no reason why the spirit side of a human being should freeze up. The heart in a true life may be young at ninety, and the mental powers active, if the person so desires. This has been demonstrated over and over again. Such names as Johnson, Newton, Humboldt, Bismarck, Noah Webster, bear striking testimony of what enthusiasm may accomplish for old age.

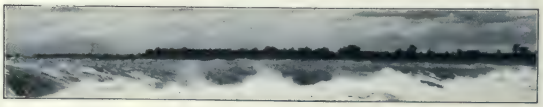
When Things Go Wrong

With most people there is a tendency to despondency when circumstances go against them, but we should remember that ofttimes a disappointment may in reality be a stepping-stone to some genuine success. When Huxley and Tyndall applied to the University of Toronto, Canada, for professorships, their disappointment was great when their applications were refused; but the very fact of their remaining in Great Britain led to paths in which they made their names rank with the greatest in modern science. The disappointment or failure of a certain plan is oftentimes a blessing in disguise. The next time you feel despondent, look out of the window, and within five minutes you will see something to make you thankful.

The Chicago Man

No citizens of the United States are so enthusiastic over the prosperity, the greatness, and the future of their city as the people of Chicago. There is a certain story told that a prominent business man of Chicago, who, like the rest of his fellow townsmen, had a very exalted opinion of his city, died, and when he reached his eternal home, he looked about him with much surprise and said to the attendant who had opened the gate for him, "Really this does great credit to Chicago. I expected some change in heaven." The attendant eyed the Chicagoan a second, and then observed, "This isn't heaven."

"The wise and active conquer difficulties
By daring to attempt them; sloth and folly
Shiver and sink at sight of toil and hazard,
And make the impossibility they fear."



In order to receive attention in the columns of THE TECHNICAL WORLD, all inquiries must be addressed to the Consulting Department.

Calculation of Columns

Question: Kindly explain how to carry out the exact calculation of columns when they are eccentrically loaded.—*E. C.*

Answer: According to Merriman, the following formulæ are nearly exact for eccentrically loaded columns:

$$(1)\quad \theta = \frac{L}{2r}\sqrt{\frac{B}{E}}$$

$$(2)\quad C = B\left(1+\frac{pc}{r^2\cos\theta}\right)$$

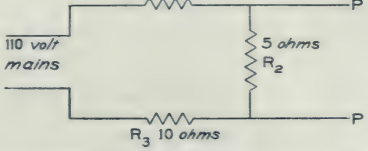
In these formulæ, C is the safe compressive strength of the material; B, the load per square inch of section; p, the distance of the eccentric load from the center of gravity of the column; r, the radius of gyration; c, the distance of the center of gravity from the outside of the side of the column which is in compression; L, the length of the column in inches; and E, the coefficient of elasticity.

To use these formulæ, select a column, and divide the total load by the area of cross-section. This will give B. We can now solve for θ, using equation (1), since all the quantities are known. The angle θ, found in this way, will be in radians. To change this angle to degrees, multiply by 57.3. Having found the angle θ, all of the quantities in the right-hand member of formula (2) are known, and we can solve for C. This will give us the maximum compressive stress in the outer fiber. If this happens to be approximately the allowable compressive strength of the material, the selection is good, and this will be the section to be used for the load. If it is found that the compressive stress is too low or too high, we must carry the same problem through, using a different section.

If there is an axial load as well as an eccentric load, first find the position of the resultant of both forces by means of moments. Use the resultant obtained in this way, and carry the problem through as though it had but one eccentric load.

Calculation of E. M. F. and Current

Question: How are the E. M. F. and current worked out in the following diagram, direct current? E. M. F. and current to be measured at PP.—*W. D. H.*



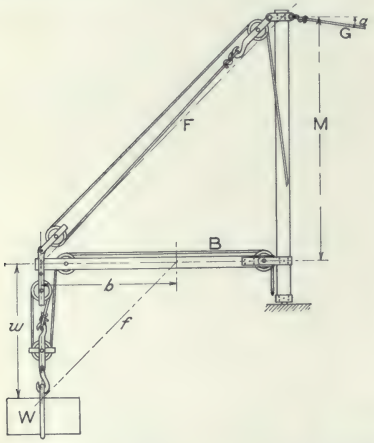
Answer: In this sketch the circuit is open at the points PP; and therefore no current whatever is flowing here, or, in other words, the current is zero. A current, however, will flow through the resistances R_1, R_2, and R_3. The current

will be the same in all three resistances, and will be equal to the voltage divided by the total resistance, or 110 ÷ 25 (= 4.4) amperes. The drop in voltage in R_1 will be equal to the product of the current and its resistance, or 10×4.4 (= 44) volts. The drop in voltage in R_3 will also be 44 volts. This will leave 110 — 2×44 (= 22) volts between the points PP. In other words, you are simply measuring the drop in voltage over the resistance R_2, which, since the current is 4.4 amperes and its resistance is 5 ohms, will be 5×4.4 (= 22) volts.

Stresses in Derricks

Question: Will you please show me how to calculate the stresses in a derrick so that I can determine the size of the mast and the guys, and also the number of guys that should be used?—*R. F.*

Answer: Problems in stresses of derricks or similar framed structures, can usually be solved by the application of the parallelogram of forces or by the method



of moments. The stress in the boom of a derrick is the same for all positions with a constant load; but the stress in the boom-fall and mast is a maximum when the boom is in its lowest position, that is, horizontal. Also, the stress in a single guy is a maximum when the boom is opposite and horizontal. The number of guys should not be less than 4.

The stresses can perhaps best be worked out by means of a concrete example. Suppose we have a derrick, as shown in the figure, in which M is the mast, B the boom, F the boom-fall, and G a guy. W equals the load, which we may suppose to be 10 tons. The angle which the guy makes with the horizontal is *a*. If we let the line *w* at the end of the boom represent the load drawn to a certain scale, and then complete the triangle, making the sides *f* and *b* parallel to the boom-fall and boom, these lines will represent the respective stresses.

The other stresses can be found by graphics also, but the following general solution is somewhat simpler:

Expressed as a factor of the weight W,

$$\text{Total stress in main fall} = W$$

$$\text{Total stress in boom-fall} = W \times \frac{F}{M}$$

$$\text{Total stress in boom} = W \times \frac{B}{M}$$

$$\text{Total stress in the mast} = W \times \left(1 + \frac{B}{M} \times \tan a\right)$$

$$\text{Total stress in guy} = W \times \frac{B}{M} \times \sec a.$$

The maximum stresses as explained above, occur when the boom is horizontal, and these formulas hold true for this position. Assuming the length of the boom to be 40 feet; of the mast, 45 feet; and angle *a* to be about 7°, these stresses would be 20,000, 26,760, 17,780, 22,220, and 17,920 pounds respectively.

If we had pulleys with six supporting ropes for the falls, with a winding drum on the mast, 1-6 of the strain in the boom-fall would have to be added to the compression already in the mast. This gives 4,460 + 22,220 (= 26,680) for the total compression in the mast. Similarly, we must add 1-6 of the stress in the main fall to the stress already in the boom, which gives 3,330 + 17,780 (= 21,110). Allowing as a maximum stress in the wood 8,000 pounds per square inch, and a factor of safety of 5, we have

$$\frac{26{,}680 \times 5}{8{,}000}$$ (*i. e.*, about 17) square inches

for the cross-section of the mast. Similarly the boom requires about 14 square

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inches. The total strain on the guy is about 18,000 pounds, or 9 tons; and allowing a factor of 5, it would require a galvanized iron wire rope 5½ inches in circumference to sustain this strain. These sizes can be obtained from any manufacturer's catalogue.

The above figures are approximate only, and do not take into consideration the weights of the various members. These weights, of course, should always be considered in the case of heavy derricks; and, when the sizes have been approximately determined, the calculation should be repeated, allowing for the extra weight.

Location of Cut-Out Block

Question: Please inform me why the Board of Underwriters require cut-out block between mains and service switch instead of the reverse. Switch first and then cut-out is safer for all concerned, in my opinion.—*J. P. D.*

Answer: The Underwriters require all wiring and apparatus in the building, including the service switch, to be protected by the fuses or cut-out. Therefore the cut-out should come before the switch; otherwise the switch would not be protected, and hence the requirements would not be fulfilled.

Torque and Lagging Current

Question 1: Of which of the following is the torque of a D. C. motor considered to be the result:—Magnetic poles of opposite name being brought in proximity; or the tendency of a current-bearing wire to rotate about a magnetic pole?

Question 2: Does the current in a secondary of an alternating-current transformer alternate a quarter of a cycle behind that in the primary?—*E. O. M.*

Answer 1: The torque of a motor is due to the attempt of two magnetic fields to coincide. One of these magnetic fields is due to the field coils, and the other is due to the armature current. These fields are kept at right angles by the location of the brushes which govern the direction of the field of the armature. As stated, the tendency of the two fields to come into coincidence produces the torque; hence the torque varies almost directly as the armature current and almost directly as the field current, leaving aside the change of permeability of the magnetic paths. For series motors, the torque varies approximately as the square of the current, because the same current flows in both the armature and the field. If the brushes were shifted around 90° from the normal point—supposing that to be possible—then the two fields would be in the same plane, and the torque would be zero. This condition, however, could not be realized, because of the sparking and racing of the motor which would take place.

Answer 2: Under non-inductive load conditions, the primary current and E. M. F. are almost in phase, and are displaced nearly 180° from the secondary current and E. M. F., the two latter being in phase with each other. Under very light load conditions, provided the core losses are small and the magnetizing component of the current comparatively large, there may be much less than 180° difference between the primary and secondary current; but this difference can never become as small as 90°.

Methods of Graduating Instruments

Question: Please tell me how such instruments as are graduated on the face are manufactured—for instance, protractors or scales. Are they stamped or cut? Also where can I get detailed information on the subject?—*W. H. K.*

Answer: There are several ways of making graduated instruments. The specific manner adopted depends a great deal upon the intended use of the instrument. The best mathematical instruments are graduated by dividing engines. Frequently, however, protractors and scales are simply made by stamping, or by comparison with some standard. Instruments thus made are to be avoided for accurate work. Graduations are made for so many different purposes—such as thermometers, scales, steam gauges, etc.—that it is impossible to give one general description of the method of the manufacturing. For a detailed description of the dividing engine, which is really essential for accurate graduations, you may refer to some good cyclopedia, such as "Appleton's Cyclopedia of Ap-

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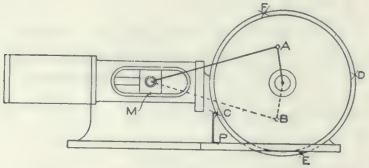
plied Mechanics." There is an article in the *American Machinist* of May 7, 1896, describing several dividing tools. There are also a number of other articles on this same line in the June and July issues of 1898.

Placing an Engine on Dead Center

Question: Kindly explain by means of a sketch, the method of placing an engine on dead center.—*J. D.*

Answer: When setting the valves of a steam engine, it is necessary to place the engine on dead center. The operation of setting a valve is rather delicate; and, therefore, one must be able to place the engine exactly on dead center.



To do this, place the crank in a position similar to position A in the sketch. Scratch a mark on the crosshead, and another exactly opposite it on the guide, as shown at M. Make a center punch mark on the floor or any other convenient place, as P. With one end of a tram placed on the point P, scratch a mark C on the rim of the fly wheel with the other. Now turn the engine over so that the crank occupies a position similar to its original position, but on the opposite side of the center line, as shown in the dotted position B. When the crank is in the correct position, the mark on the crosshead will again be exactly opposite the mark M on the guide.

Again place one end of the tram on point P, and scratch a mark on the rim of the fly wheel D. Now bisect the arcs between the points C and D, obtaining the points E and F. To bring the engine on head-end dead center, it will be necessary only to place one end of the tram on the point P, and bring the fly wheel to rest when the mark F is exactly opposite the other end of the tram. In the same way, by holding the tram in this position, and turning the fly wheel until the mark E is exactly opposite the end of the tram, the engine will be on crank-end dead center.

Heating of Water

Question: I have a boiler containing 150 two-inch seamless copper tubes 4 feet long. I have a sufficient quantity of exhaust steam at 2 pounds' pressure to supply this, and should like to know how many gallons of water per hour I can raise to a temperature of 130°, the water being taken in at a temperature of 65° F.

Will you please give all the calculations for this, so that I can follow them and thus be able to work out the quantity for other temperatures?—*M. A. M.*

Answer: In heaters of this kind, it is customary to assume that each square foot will give 200 B. T. U. to the water per hour for each degree difference in temperature between the surrounding water and the steam. In the case at hand, the average temperature of the water is $\frac{1}{2} \times (130 + 65)$, or 98 degrees. The temperature of steam at 2 pounds' pressure is 219° F. This can be obtained from any table of the properties of steam. Consequently the total difference in temperature between the steam and water is 219 — 98 (= 121) degrees. We may allow approximately 1.6 feet of pipe for each square foot of heating surface. To determine this accurately, the pipe should be measured and the circumference calculated. Since there are 150 tubes, each 4 feet long, we have 600 feet of tubing; and the total surface, allowing 1.6 feet per square foot, is 600 ÷ 1.6, or 375.

The total quantity of heat given off per hour, then, is equal to the number of square feet, times the efficiency, times the difference in temperature, or $375 \times 200 \times 121$ (= 9,079,000). The water is to be raised from 65° to 130°, or 65° in all; and each pound which is heated to this extent will require 65 heat units. Since there are 8.3 pounds to the gallon, every gallon raised 65° will require 8.3×65 (= 540, approximately) heat units. Since the total number of heat units is 9,079,000, the number of gallons which can be heated in one hour is 9,079,000 divided by the heat necessary for one gallon, or by 540. This gives 16,810 for the number of gallons which can be heated in one hour.

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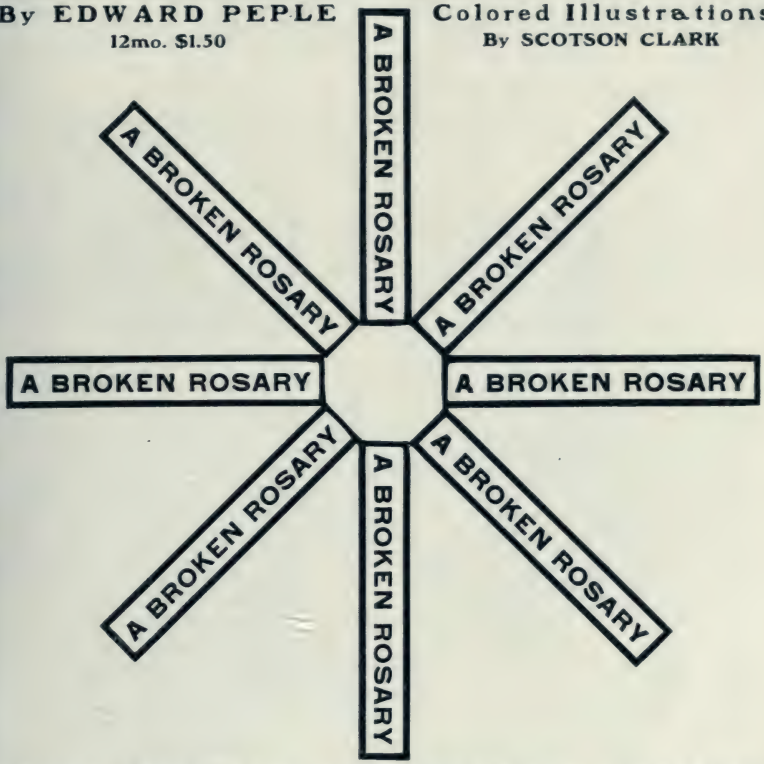

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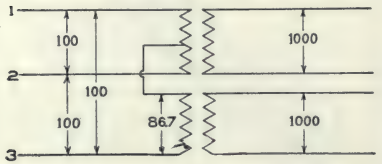
Transforming of Electric Currents

Question 1: Please explain how the change is made in transforming the three-phase current to two-phase in transmission lines.

Question 2: Also please explain the method of transforming high voltage three-phase, and feeding into incandescent mains.—*P. W. Q.*

Answer 1: It is possible to change from three-phase to two-phase, or the reverse, by means of the arrangement



shown in the accompanying sketch. Two transformers are used, one wound as shown for transformation of 100 to 1,000, and the other for transformation of 86.7 to 1,000. In other words, the transformation ratio must, in the first case, be 1 to 10, and in the second case .867 to 10.

Answer 2: We may treat the three-phase system as three separate single-phase systems, connecting a single-phase transformer across two of the mains, thereby stepping the voltage down to 110, and treating the circuit as a single-phase 110-volt parallel system. When this method is used, care, of course, should be taken to keep the system as nearly balanced as possible. This is the simplest method.

Another method consists in using three transformers, the primaries being connected to the three lines, delta or star, as the case may be; the secondaries being likewise connected up, and carried to the cut-out boxes; and the load being then balanced up on the three phases. There are several other methods of stepping-down and connecting to the lamps, but the above are perhaps the most common.

Cause of Pump Failure

Question: Why does a pump fail to work sometimes when pumping against heavy pressure?—*B. R. T.*

Answer: There may be a number of reasons; but it often happens on account of full pressure resting on the discharge valves. Under these conditions the water in the pump cylinder is simply compressed and prevents water entering the cylinder. By suitable connections in a pipe, and a waste delivery, the water can be expelled without any pressure, if the pump is started and run for a while.

Center of Gravity—Water-Gauge Pressure—Size of Air Fan

Question 1: How do you find the center of gravity of a wrought-iron lever 30 inches long, ¾ inch thick, 2¼ inches deep at one end, and 1⅞ inches at the other?

Question 2: A water gauge shows 2.4 inches; what is the equivalent per square inch in gauge pressure? Give a rule for changing the same.

Question 3: How do you find the size of a fan required for lifting a given quantity of air from a shaft at a given pressure?—*D. B.*

Answer 1: The center of gravity of any regular figure, whether plane or solid, is the same as its geometrical center. Since the face of the lever is a trapezoid, we know that its center of gravity must lie on a straight line joining the middle of the two bases. Its distance from one end can be determined by the method of moments. Consider the trapezoid to be made up of a parallelogram and a triangle, the center of gravity of each of these figures is easily obtained, since it is the geometrical center. That of the parallelogram will be 15 inches from either end; and that of the triangle will be 20 inches from one end, and 10 inches from the other. The sum of these two moments about an axis through the center of the parallelogram, is $2\frac{3}{8}$. Dividing this sum by the sum of the weights of the parallelogram and triangle, we obtain $2\frac{3}{8} \div 4\frac{3}{8}$ $(=\frac{5}{11})$ inches for the distance of the center of gravity from the axis of reference. In other words, the center of gravity is 15 5-11 inches from the smaller end of the bar. Since the lever is of the same thickness, ¾ inch throughout, the exact center will be ⅜ of an inch from the surface of the bar. Practically the quickest method would be by balancing the lever on a knife edge.

Answer 2: The equivalent of 2.4 inches of water is .0864 pounds per square inch. One inch of water at 62° F. is equivalent to a pressure of .03608 pounds per square inch.

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Answer 3: Knowing the quantity of air necessary to be raised, and also the pressure which is necessary, the size of fan can readily be determined from any manufacturer's catalogue by referring to tables giving the size and capacities. The capacity decreases and the power increases materially, since the resistance resulting from lengths, smallness, and bends of ducts, enters as a factor. As the pressure which is necessary to overcome this is known, the problem is very simple. It is necessary only to remember that the pressure varies as the square of the speed, and that the power varies as the cube of the speed. Hence for fans of the required capacity not rated, sizes either larger or smaller can be used; and by the rules given, the necessary speeds can be determined.

Lubrication of Wire Ropes

Question: Is it advisable to galvanize wire ropes subjected to constant bending around sheaves and drums?—*C. G. N.*

Answer: Such ropes are not usually so treated; but it is essential that they be kept well lubricated by the frequent application of oil, or some similar material, free from corrosive substances. A good waterproof graphite grease, gives satisfactory results as a lubricator.

Current and Construction Problems

Question 1: Why does not current flow from the primary lines of an alternating-current system to the transformer when the lamps are cut out of the secondary circuit?

Question 2: What is the difference in construction of a shunt-wound dynamo compared with a motor equal in design, voltage, etc.? Would one fill the place of the other?—*E. N. B.*

Answer 1: A current does flow through the primary of an alternating-current transformer even when the secondary circuit is entirely open. It is, however, very small, and is what is called the "open-circuit" current of the transformer. A large current does not flow, because, when the secondary is open, the primary acts as a choke coil, the counter E. M. F. of self-induction cutting down the current to the small amount mentioned.

Answer 2: A shunt-wound dynamo or motor will work interchangeably; but with identical machines and with the same field strength, the speed of the generator will be greater than that of the motor for a given brush voltage, because the actual E. M. F. of the generator is equal to the copper drop *added to* the terminal voltage, whereas that of the motor is equal to the terminal voltage *diminished by* the copper drop. Hence the motor does not need to generate as high an E. M. F., and consequently will not rotate as fast. Another difference is that a motor does not generally require a rheostat in its field winding, as is the case with the generator, hence the motor field will have a higher resistance.

Cast Steel and Steel Castings

Question: State the difference between cast steel and steel castings. Which is the better material?—*L. McD.*

Answer: Cast steel is made by the crucible process, being cast into bars. Steel castings may be made from Bessemer or open-hearth steel. The crucible is the more reliable, greater care in this case being taken in the production and pure materials being used, the process taking place in closed crucibles.

Use of Compressor and Condenser

Question: For what are the compressor pump and condenser used in connection with mechanical refrigeration?—*F. P.*

Answer: To reconvert the gas into a liquid after evaporation, thus making the original charge of ammonia available over and over.

White Cement

Question: Give formula for a white, quick-setting cement which constant dampness will not affect, and which can be finished smooth.—*O. S. O.*

Answer: Any of the German Portland cements, such as the "Dyckerhoff," "Germania," or "Porta" brands, having analyses similar to the following: Silica 21.14 per cent; alumina 6.30 per cent;

(*Concluded on page 487*)

iron oxide 2.50 per cent; lime 66.04 per cent; magnesia 1.11 per cent; carbonic acid, water, and loss 2.91 per cent.

Output of Ice Machine

Question: What is the tonnage of my ice machine? The dimensions are:—Diameter of cylinder, 6½ inches; length of stroke, 12 inches; number of revolutions per minute, 90; condenser pressure, 120 lbs.; back pressure or return pressure, 20 lbs.; outlet pipe 1½ inches; and suction pipe 2 inches. Also what horse-power will it take to run this machine?—*B. H.*

Answer: As you have failed to give the temperature, we can give you approximate results only. Squaring the diameter of the cylinder, and multiplying by .7854, gives you the area of the end. Multiplying this by 12 gives you the volume in cubic inches, and multiplying by 90 gives 35,838 cubic inches as the volume per minute.

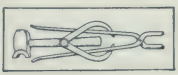
As it is necessary to take away from the evaporator nearly 7,000 cubic inches of gas per minute for each ton of refrigeration developed in 24 hours, you should divide by 7,000, which would give you approximately 5 tons for each 24 hours.

In regard to the horse-power, it may be said that under ordinary conditions about 2½ H. P. is required for each ton produced. You would therefore need approximately 12½ H. P.

Management of Bonnet Doors

Question: What effect does leaving bonnet doors open over night have on boiler flues, after the boiler has been in use during the day?—*W. W.*

Answer: Drafts would be caused, which would chill, and thus injure, the hot tubes of the boiler. Under certain conditions the draft might cause the smoke to be blown out through these doors into the boiler room.



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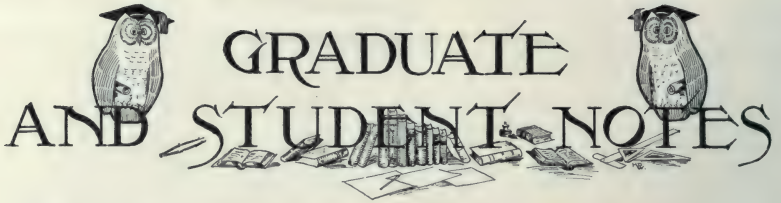

Second Annual Reception

ALL ARRANGEMENTS have been perfected for the reception to be given by the Armour Institute of Technology to the students of the American School of Correspondence on Friday evening, June 17.

Last year 5,000 students were in attendance; this year we expect as many more.

Senator Dolliver, who delivers the principal address, is one of the most widely known men in the United States Senate, a master of public speech, and thoroughly familiar with the trade conditions of the United States. His address is sure to be full of interest. He has chosen for his topic "A Poor Boy's Country," a title in itself full of suggestiveness.

Dr. Gunsaulus will preside and also speak. Do not fail to make a note of this date, Friday, June 17th.

Last year several hundred students from other parts of the country were in attendance and had a splendid time. Try and adjust your affairs so that you may be present to hear Senator Dolliver and Dr. Gunsaulus, two of the best known public speakers of the day.

After the meeting, guides will be in attendance to take the students and their friends through the buildings of the Armour Institute and the American School.

Recently Graduated

THE FOLLOWING STUDENTS have been graduated from the American School of Correspondence since the last number of THE TECHNICAL WORLD was issued:

Alickson, A., Winnebago City, Minn.—Course: Stationary Engineering.

Allen, D. A., Ellsworth, Ohio—Course: Electrical.

Applegate, R., Batavia, Ohio—Course: Stationary.

Batchelder, L. J., Laconia, N. H.—Course: Mechanical.

Dentall, Frank William, The Lines, Earls, Colne, Essex, Eng.—Course: Electrical.

Bivans, Frank H., Port Bryan, N. Y.—Course: Mechanical.

Bonnett, J. C., New Haven, Ct.—Course: Mechanical.

Boostrom, A., Galva, Ill.—Course: Mechanical.

Breest, Francis, Arbor Vitæ, Wis.—Course: Electrical.

Clark, M. D., Englewood, Ill.—Course: Electrical.

Clinehens, E. W., Maplewood, Ohio—Course: Locomotive.

Davis, Arthur A., Clark's Green, Pa.—Course: Heating, Ventilating, and Plumbing.

Davis, Fred H., Silver Creek, N. Y.—Course: Marine.

Dayton, Redington N., East Norwalk, Ct.—Course: Mechanical.

Dorman, G. L., Lexington, Mich.—Course: Electrical.

Erskine, Harold L., Bristol, Me.—Course: Fireman.

Evans, Chas. H., Evanston Farm, Erie, Pa.—Course: Electrical.

Fabian, Norman J., St. Paul, Minn.—Course: Mechanical-Electrical.

Fuller, Arthur C., New London, Ct.—Course: Electrical.

Harbaugh, Verde L., Southwest, Pa.—Course: Electrical.

Hartwig, Wm. Jr., West Point, Neb.—Course: Electrical.

Hill, Howard J., Winnebago City, Minn.—Course: Stationary.

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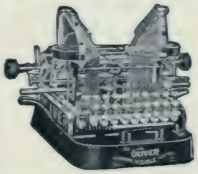
If you are the kind of man we are seeking, we will enter into details by correspondence on receipt of your inquiry.



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GRADUATE AND STUDENT NOTES—(Continued)

Howell, W. H., Gaylord, Kansas—Course: Mechanical.

Jennings, Chas., Cambridge, Mass.—Course: Stationary.

Johnson, Boyd O., Indiana Harbor, Ind.—Course: Stationary.

Johnson, H. Bert, Richmond, Va.—Course: Special—Heating and Ventilating.

Kenyon, J. A., Ironwood, Mich.—Course: Central Station Work.

Kimball, Ray C., Milbank, S. D.—Course: Stationary.

Lafleur, Paul, Westmount, P. Q.—Course: Electrical.

Lewis, E. A., Butternut, Mich. — Course: Electrical.

Macloon, Ernest Henry, Copperfield, Vt.—Course: Electrical.

Maughner, J. W., Newport, Ind.—Course: Electrical.

Menocal, A. J., Washington, D. C.—Course: Electrical.

Montgomery, W. C., Alexandria, Ind.—Course: Mechanical.

Norton, Floyd, Charlevoix, Mich.—Course: Marine.

O'Neill, Wm., Baltimore, Md.—Course: Mechanical.

Pattingill, Ira, St. Louis, Mo.—Course: Mechanical-Electrical.

Porter, John J., Buena Vista, Va.—Course: Mechanical.

Putney, A. L., Winnebago City, Minn. — Course: Mechanical-Electrical.

Reuter, Geo. B., Pomeroy, Ohio—Course: Mechanical.

Reynolds, Harry, Antigo, Wis.—Course: Electrical.

Richards, W. B., Altoona, Pa.—Course: Locomotive.

Ross, H., New York City—Course: Stationary.

Schenck, Otto V., Huntingburg, Ind.—Course: Mechanical.

Schneller, Heinrich, Brooklyn, N. Y.—Course: Mechanical.

Shupe, Emmet C., Kingston, O.—Course: Locomotive.

Smith, P. O., Cantril, Ia.—Course: Complete Mathematics.

Smith, W. R., Albany, Ill.—Course: Stationary.

St. John, M. Carroll, Rayne, La.—Course: Mechanical.

Swanson, August, Vasa, Minn. — Course: Electric Lighting.

Swartwood, C. I., Holdrege, Neb.—Course: Stationary.

Thomas, Roy N., Skaneateles, N. Y.—Course: Mechanical-Electrical.

Thompson, U. M., Santa Cruz, Cal.—Course: Stationary.

Turner, Herbert M., Quincy, Ill.—Course: Mechanical.

Wagner, Wm. B., Forestville, Mich.—Course: Mechanical-Electrical.

Wauchope, J. M., Winterset, Ia.—Course: Electrical.

Whiting, Louis D., Milldale, Ct.—Course: Mechanical.

Wilson, Geo. W., Paradise, N. S., Can.—Course: Stationary.

Our Premium Offers

DURING THE MONTH OF MARCH, W. T. Anderson, 13 Oakwood Place, Orange, N. J., secured considerably over fifty subscriptions to THE TECHNICAL WORLD. As premiums, in accordance with our Premium Offer, he received a Drawing Outfit, one copy of "Practical Lessons in Electricity," and the "Compendium of Drawing;" and in addition was awarded a set of the "Reference Library" for securing the largest number of subscriptions during the month. *We are continuing these Premium Offers.* A little work on the part of students or subscribers, showing the magazine to friends and interesting them in it and in the School, will bring abundant results; and such efforts are amply rewarded. For particulars as to the Premium Offers, see advertising pages.

Our Exhibit at St. Louis

Located in the Palace of Electricity, Section 19, Aisle Z.

THE AMERICAN SCHOOL OF CORRESPONDENCE EXHIBIT at the St. Louis Exposition has been open since May 1st, for the reception of visitors. Mr. E. E. Dewey, State Secretary for Illinois, is in attendance, and will remain during the Fair. We hope our students and their friends visiting the grounds will make the School Exhibit their headquarters. There will be much to interest them in the way of apparatus, drawings, patterns, etc.

Note that the location of the Exhibit has been changed from Aisle Y to Aisle Z. The School expects to make arrange-

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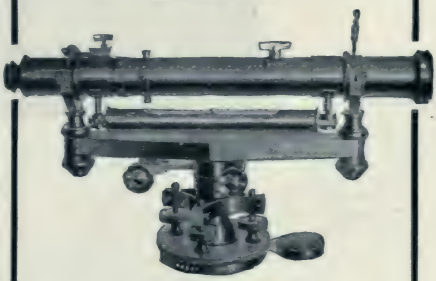

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ments with one of the railroads for a special excursion from Chicago to St. Louis, to leave Chicago on the night of June 17. This is the same date as the reception, and will afford an opportunity for students in different parts of the country, who intend visiting the Fair, to break the journey at Chicago, attend the reception, and then go direct to the depot and leave for St. Louis. To facilitate the arrangements, we desire that all who intend to take advantage of this excursion communicate at once with the Excursion Department, American School of Correspondence, 3321 Armour Ave., Chicago.

BOOTH CONTAINING EXHIBIT OF THE AMERICAN SCHOOL AT THE ST. LOUIS EXPOSITION.
Located in Palace of Electricity, Section 19, Aisle Y.

An Item from the Field of War

THE PRESENT CONFLICT in the Far East has temporarily—and possibly, in some cases, permanently—interrupted correspondence with students and inquirers in the sections comprised within the seat of war. On several occasions recently, letters and other matter sent from the School have been returned, in every case bearing the official imprinted notification of inability to forward on account of the campaign. One of the most interesting of these items was intended for a young man aboard the Russian cruiser *Diana* at Port Arthur. This vessel was temporarily disabled during one of the Japanese attacks, but was in sufficiently good sea-going and fighting trim to participate in the fight in which the flagship *Petropavlovsk*, with Admiral Makaroff aboard, was lost. When normal conditions are resumed—which, it is hoped, may be soon—much material of great interest may be expected from this far-distant quarter.

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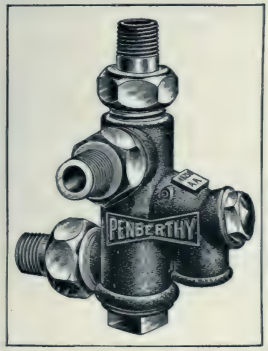

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GRADUATE AND STUDENT NOTES—(Continued)

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THROUGH THE GENEROUS GIFT of Mr. J. Ogden Armour, the Armour Institute of Technology comes into possession of the splendid athletic field shown in the accompanying picture. At the present time no addition to the Institute could better please the students than well equipped athletic grounds. For the athletic purposes of the Armour students, the situation of Ogden field is excellent, covering the block from 32d to 33d streets. When the houses are cleared away, this large open space is certain to transform the neighborhood. In the coming season we expect to see the letters "A. I. T." cut a wide swath in college athletics.

OGDEN ATHLETIC FIELD.

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Summer Courses at Harvard

HARVARD UNIVERSITY offers during the Summer of 1904 the following courses of study of interest to students of Engineering, Physics, Chemistry, Geology, Geography, Botany, etc. Courses in Plane and Topographical Surveying, Railroad Surveying, and Geodetic Surveying, are offered at Squam Lake, New Hampshire, commencing June 18, and continuing for eleven weeks. Courses in Shopwork (including Chipping, Filing, and Fitting; Blacksmithing; Pattern Making and Foundry Practice; and Machine Shop Practice) will be given in Cambridge, beginning about June 20, and ending about July 16. Courses in Physics, Chemistry, Botany, Geology, Geography, Commercial Geography, Architectural Drawing, Mathematics, English, French, German, Latin, Greek, History, Economics, Philosophy, Psychology, and Drawing and Painting, will be given in Cambridge beginning July 5, and ending August 12.

The tuition fees for these courses vary from $20 to $30, and living expenses will vary from $5 to $8 a week. The "Announcement" of the Summer School, including descriptions of all these courses, with information about expenses, reduced railway fares, etc., may be obtained by addressing the *Clerk of the Summer School, 16 University Hall, Cambridge, Mass.*

News from Afar

HARRY WOODS, of Cachas, India, assistant manager and engineer on a large tea plantation, gives a very interesting account of his work:

"This estate has 1,600 acres under tea cultivation; and I have 300 acres with a large force of 600 men under my personal management, together with the factory. Our output is 640,000 lbs. of tea per season, the manufacturing season being from April to December.

The engineer of such a plantation, besides having the machinery to look after, is responsible for all bridges, roads, etc.; so you see a mechanical engineer out here, after a little time, becomes what may be called a Jack-of-all-trades.

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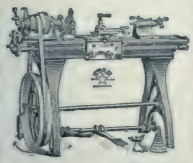

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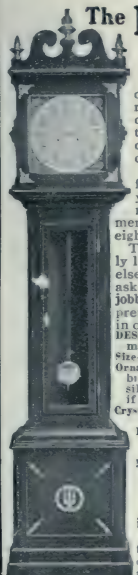

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If, after 10 days' use, it proves satisfactory, remit us its price, $29.50. If you want the clock, and are unable to remit the entire amount in one payment, send us $8, and $3 per month for eight months.

This beautiful Colonial timepiece, exactly like photograph, cannot be duplicated elsewhere for several times the price we ask. We eliminate the profits of salesmen, jobbers and retailers, and deliver it to you, prepaid at the rock-bottom price of $29.50 in one payment, or $32 in nine payments.

DESCRIPTION—Constructed of polished cherry, mahoganized, or polished, selected oak.

Size—Height 7½ feet. Weight 150 pounds.

Ornaments—Etruscan ornaments, solid cast brass, polished. Top ornaments, brass and silver. Can be furnished without ornaments if desired.

Crystals—Both doors French, extra heavy, polished bevel crystals.

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with cigars that suit their tastes will appeal to you if you give the subject careful thought. You assume absolutely **no risk.** Men who smoke cigars have widely varying tastes. It would therefore be folly on our part, inasmuch as we want your permanent patronage, to try to urge upon you the use of any one brand of cigars.

As manufacturers of a long list of time-tested brands, formerly sold to the jobbing trade, embracing all sizes, shapes, colors and grades, this is unnecessary. We do not want your patronage unless we can give you absolute satisfaction; unless we can suit your individual taste, **you only to be the judge.** We are enabled to make the saving to you for the reason that neither jobber, salesman nor retailers secure a profit from the transaction These three profits, in the ordinary way of selling cigars, **equal at least 50 per cent.** The selections you make are all shipped **transportation charges** prepaid,

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Every cigar we make costing you over $3.00 per hundred is constructed of clear, pure, imported Havana tobacco, and all cigars are made under the best improved sanitary conditions. Under this guarantee, we name below a few brands from our complete catalogue, and invite a trial, assuring you that if we do not suit you the expense is ours. Boxes of

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Piconcios,	4½ in. Conchas,	$1.00	$1.75	$3.50
El Provost,	4⅝ in. Perfectos,	.85	1.50	3.00
Pedora,	4⅜ in. Londres,	.60		2.00

or for **75c,** we will gladly send you an assortment of 12 cigars showing four varieties of 10c. and two for a quarter values: or for **50c,** an equal showing of High-grade 5c. and 10c. values. Each cigar separately wrapped and described. Send for our catalogue, "Rolled Reveries," which explains everything.

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At this time of the year (10th of September) our day commences at 5:30 A. M. and ends at 5:30 P. M. for outdoor work, and the factory is mostly running 20 hours out of the 24; so sometimes I am not in my bungalow four hours out of the day, and then there are always business letters to write. When the manufacturing season closes, the machinery must be overhauled; and every year since I have been out here, we have had new machinery to install."

After reading Mr. Woods's letter, it is safe to say that outside of the time he devotes to study he has not much leisure.

MR. BERT TEAGUE, one of our students in Pretoria, South Africa, has an excellent position with the C. S. S. Ry. Co. Previous to entering the railway service, he had charge of several departments in the construction work of the Port Elizabeth Harbor, and also in the Cape Town Harbor Works. During the war between Great Britain and the Transvaal, Mr. Teague served as a volunteer, and saw a good deal of fighting.

B. TEAGUE.

From a New Zealand Student

OUR AMERICAN READERS will find much of interest in the accompanying photograph of a camp scene in the life of a government surveying party in Taranaki, North Island, New Zealand. Mr. Watson, the surveyor in charge of the party, is standing just behind the theodolite. The chainman on the left of the picture is Mr. H. Rawson, a student of the American School, to whom we are indebted for the illustration. Scenes of similar interest could be multiplied a thousand times from the surroundings and daily occupations of our enlisted students in this progressive British Colony of the South Seas.

Opportunities in Korea

KOREA is at the present moment the center of human interest. Probably six months ago very few people could have named a single city or river in the Hermit Kingdom, but now Seoul, Wonsan, Ping-Yang, and Yalu slip from our lips as easily as if we had known them from childhood.

Mr. W. A. Noble, one of the missionaries of the M. E. Church, and a graduate of the American Institute of Tennessee and Drew Theological Seminary of New Jersey, has charge of the Station at Ping-Yang, Korea. Mr. Noble realizes the great help an industrial school would be in furthering the interests of his mission; and to bring about that end he has enrolled in our Stationary Engineering Course. A good healthy industrial school will go a great ways toward advancing and elevating the average Korean. When Mr. Noble finishes his course, he will be fully equipped to conduct the affairs of such an institution. It is hoped that his example will do much to inspire other missionaries to engage in the establishment of schools of this class.

SURVEYING CAMP IN NEW ZEALAND.

A Word of Praise

IN THE LINE of electrical instruction, the St. Louis Exposition can also show a typical American novelty, nearly unknown to the European practice—that is, The American School of Correspondence. The exhibit of this institution will give full testimony of the success which has been attained by this unique method of teaching, speaking for its excellency and the ability of the promoters. It must be

This volume weighs five pounds and is held by one leaf. So much for the quality of binding and paper.

This new edition of

Battles and Leaders of the Civil War

IS SOLD ON AN EASY PAYMENT PLAN

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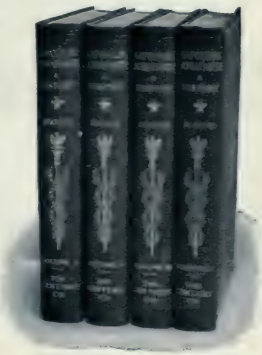

Editorially, mechanically, and artistically this work is a wonder. It is the only complete, *impartial* account of the great Emperor's life. All others have tended toward hero worship or erred to an equal extent on the other side. Professor Sloane was thoroughly equipped for this work through exhaustive study of all the Napoleonic literature obtainable and by extensive travel over the scenes of Napoleon's struggles, affluence, and subsequent downfall.

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admitted that for a certain class of students, and under the peculiar conditions of such a large country as the United States, this method of teaching certainly has its right of existence.—*Electrical World and Engineer.*

Shipbuilding in China

SHANGHAI, CHINA, the British treaty port, is one of the most prosperous cities in the Far East, and known to readers of modern history as the model settlement of the Orient. It was here that the first Chinese railroad, a few miles long, was built in 1876.

In Shanghai, Mr. T. McNider, one of our students in Electrical Engineering, is foreman of one of the workshops of the Dock Company. The principal work carried on by this firm is the repairing of ocean steamships and the building of

U. S. Transport and Cable Ship "Burnside."

coasting and river steamers. In 1892 this Company built fifteen gunboats for the revenue service of the Philippine Islands. A model of one of these gunboats has been sent to the St. Louis Exposition, to show what excellent work along the line of shipbuilding can be done in China. The accompanying illustrations represent one of these gunboats and the United States transport and cable ship *Burnside.*

Personal Items

Mr. Arthur Brake, of Chicago, has recently sent the American School a steam engine which he designed and made entirely himself. This excellent piece of work will be seen in the exhibit of the School at the St. Louis Exposition.

Gunboat for Revenue Service in the Philippines.

E. C. C. K. Fram, of Copenhagen, Denmark, will soon graduate in our course in Marine Engineering. When Mr. Fram receives his diploma it is his intention to come to the United States and settle in Philadelphia.

Mr. W. D. Krausch, architect for the C. B. & Q. Railroad, has sent a number of exceedingly interesting elevations of stations, etc., for our exhibit at the World's Fair.

J. S. Bogart, of San Francisco, California, has recently been appointed Superintendent of Buildings by the well-known firm, The Pacific States Telephone & Telegraph Company.

Mr. Peter Ramires, of Madrid, Spain, a Lieutenant in the Sixth Mounted Artillery, and now on the staff of the First Army Corps, is doing excellent work in his studies. In a recent letter, Lieutenant Ramires tells that in 1898 he was sent to Cuba, and took part in the Spanish-American War. It is the intention of the Lieutenant when his course is completed, to make a trip to the United States and visit the American School.

Lieut. P. Ramires.

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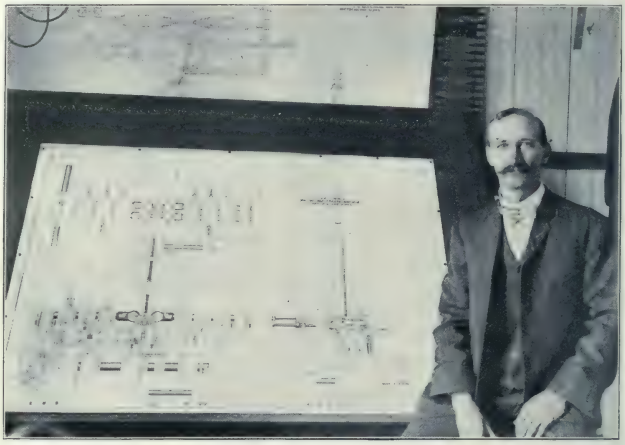
GRADUATE AND STUDENT NOTES—(Continued)

Hanover, Illinois, works almost as well as his Corliss engine. There is every reason to believe that this new machine will be a success.

B. A. SLOCUM, of Lynn, Massachusetts, is the chief draftsman in the Boston Machine Works. One of his drawings, an automatic butt drilling machine, is part of the American School Exhibit at the St. Louis Exposition.



B. A. SLOCUM.
In Drafting Room, Boston Machine Works.

Mr. Slocum was born in Japan. He is the son of Captain Slocum who became famous by making a trip around the world in a cat-boat. The accompanying illustration was taken in the drafting room of the Boston Machine Works.

D. E. ATHEY, Des Moines, Iowa, in a letter referring to the benefit he has received from his studies, writes: "Aside from having my wages increased 25 per cent, I have learned to place confidence in myself. I now understand the 'why' as well as the 'how' in my everyday work."

W. A. ROGERS, one of our graduates, has charge of the Industrial Department of the Virginia Normal and Industrial Institute at Petersburg, Virginia. His earnest work has been the means of building up this new and important department of the Institute with an exceedingly high standard of efficiency.

W. D. EILER has been seven years with the Keystone Match and Machine Company, Lebanon, Pa., four years as foreman of the Assembling Department, and during the past three years in charge of the entire plant.

MR. LAWRENCE DANHOFF is working on a patent rocking grate, and has now placed his invention on the market. Wherever the grate has been tried it has given the best of satisfaction.

JOHN HANGEBERG of Youcalla, Oregon, assisted in the installation and operation of a large steam plant in that city.

MR. E. H. CARLTON, Honolulu, Hawaii, runs three 500-H. P. tandem-compound Corliss engines, which generate the electricity for the street-car system of Honolulu.

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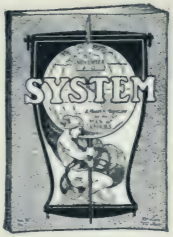

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GRADUATE AND STUDENT NOTES—(Continued)

A GOOD IDEA of the difficulties many of our students in foreign lands overcome in the mastery of their studies is found in a letter from Mr. Francisco del Salaya, Madrid, Spain. In referring to his method of work, he writes:

"I translate with a Spanish-American dictionary the subject-matter of the lesson, and afterwards work out the questions with pencil, always being guided by the instructions in the Instruction Papers. When I have the problems solved, I copy them on the Examination Papers."

MR. C. HARRISON DICKSON, Germiston, Transvaal, South Africa, is employed in the Engineering Department of

A SNAPSHOT FROM THE TRANSVAAL.
Mr. C. H. Dickson is the gentleman seated.

a large gold mine. During the war in the Transvaal he served with the Johannesburg Mounted Rifles. Was promoted to Sergeant of the Machine Gun Section, and during his term of service was responsible for the good working order of the mechanism of the guns.

MR. J. D. JACKSON, of Chicago, Ill., has recently been elected President of the N. A. S. E., No. 2. He has been extremely active in engineering circles. Through his influence many excellent programs have been arranged, and his election to the presidency indicates that his work has been appreciated.

CHARLES T. BENSON has recently patented a rotary engine for which he claims no waste of steam, and good mechanical contact. Patents have already been secured in the United States and France, and are now pending in Canada. Engineers will look forward to this new invention in the hope of seeing a rotary engine on the market that will be economically a success.

MR. T. B. MATTHEWS, of Labosa, Fiji, is one of the engineers in the well-known Colonial Sugar Refining Company, whose factories are in the Fiji Islands. In a recent letter referring to his busy life, Mr. Matthews says:

"I generally go into a mosquito-proof room by myself, and spend the evening studying until bedtime."

Speaking of his studies, our friend in these far-off islands writes as follows:

"My knowledge of engineering has greatly increased since I have been a member of the School. I reckon every man in the trade ought to take a course; and certainly those who do will never regret it."

MR. H. O. JACOBSON, recently of Minneapolis, Minnesota, passed with high grade the Civil Service Examination for a first stationary engineer's license. Nothing pleases the American School so much as to see students forge ahead.

IN ORDER to gain a practical knowledge, H. M. Patch of Stevens Point, Wisconsin, has been assisting in the running of a 250-H.-P. compound-condensing engine and T. H. alternating-current dynamo and Excelsior arc machine.

J. T. GASKILL, Philadelphia, Pa., has had the entire supervision of the installation of a new steam plant.

GEORGE TOPPING, Milwaukee, Wisconsin, a graduate in two courses, holds the responsible position of engineer in the well-known Wells building in Milwaukee.

JAMES J. JENSEN, Vallejo, Cal., is working as a wireman in order to gain practical experience. At the same time, he is pursuing postgraduate work to keep informed on all the latest and best practice.

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Catching and Stretching Threads

How to Overcome Some of the Difficulties Encountered in Machine Shop Work

By O. C. BICKFORD

A Student of the American School of Correspondence

POSSIBLY a method of "catching" threads which I have recently used may be of interest to some of your readers, so I shall give it to you.

We have occasion to thread large quantities of staybolt taps, and a new lathe was bought for this purpose, which, upon arrival, was found to have an 8-pitch lead screw. As we wished to cut a thread of 12 pitch (which most staybolts have), and must make several cuts over the tap to get a finished thread, it seemed desirable to provide some means of making sure to set in at the right position. Accordingly I made a small worm gear, having 32 teeth fitted to mesh into the lead screw of the lathe.

This I put on a short stud, run the stud up through a small block which serves as a bearing, and then fastened the block to the back end of the lathe-carriage so that the wheel would always remain in mesh with the screw. I then put a small disc, about 1½ inches in diameter, on top of the stud, graduated this disc with 4 division lines, set a pointer to the edge of the disc, and the device was complete.

As the stud carrying the worm and disc is attached to the lathe-carriage, the stud is revolved by means of the lead screw turning the worm wheel when the carriage is at rest; and then, when the nut is closed around the screw and the carriage advances, the stud becomes a stationary part of the carriage, the lead screw turning in the edge of the worm wheel as it does in the closed nut. This makes it possible to know, before setting in the threading tool, if an error has been made, because the disc stops revolving as the nut is closed, and the exact position of the pointer may be noted.

As the lead screw was 8-pitch and the worm wheel had 32 teeth, each graduation line on the disc represented one inch in the travel of the carriage.

For whole threads the nut can be closed with the pointer at any division line; while for half threads as 4½, etc., it is necessary to close the nut when the indicator points either to the division line first used or to the one opposite, these two representing points two inches apart on the screw.

I am informed that this device is in use on some makes of American lathes, though when I made this I never had seen one nor a description of it.

And now in regard to "stretching" threads, we had previously been threading these taps in lathes having a screw with stretched thread, but found it inconvenient to get such a screw for this new lathe, so set about to get the required pitch by means of the gears.

Perhaps not all of your readers know the reason for our wishing to get a stretched thread; and if so, here it is:

Steel when hardened decreases somewhat in length; and as staybolts are not hardened after threading (being usually 12 threads per inch), it becomes necessary to cut a thread of such a pitch that, after hardening the tap, the thread will measure up 12 to the inch.

By careful measurements of several taps before and after hardening, I found that they decreased in length about .004 per inch. So, by a little calculation, I found that to secure a thread that would be 12 pitch after the tap was hardened, I must cut a thread having a pitch of 11.952 threads to the inch.

I decided to approximate this at 11.95, as I found that I could cut a thread of this pitch in the following manner—by setting up the lathe with such gears that having one of 240 teeth on the screw I

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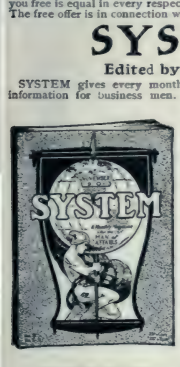

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would cut a 12 thread, and then substituting for this gear one of 239 teeth.

Now to catch this thread was the problem, which I found could be done only at points 20 inches apart on the lead screw. So I made a few small gears of the right number of teeth, and put them in a train from my indicator stud, making a ratio of 5 to 1, and terminating in another stud having a disc on top. This, for convenience, I graduated with five division lines, so that, when taking the first cut, I could start at any line on this disc, but had to set-in with the pointer at the same line for each succeeding cut on the same tap.

As the lathe must run at a comparatively slow speed when threading taps one inch or more in diameter, it would appear that much time would be lost in waiting for the right position to close the nut; but as the thread on these taps is usually from 15 to 18 inches long, there is just about time to run the carriage back before the next right position of the screw is reached.

I might add that the lead screw of this lathe is placed inside the bed of the machine, so that the indicating mechanism is very easily disposed of, and only succeeds in keeping the carriage one inch farther away from the tail block.

Steady!

A rush is good in its place, Lad,
But not at the start, I say;
For life's a very long race, Lad,
And never was won that way.
It's the stay that tells—the stay, Boy,
And the heart that never says die;
A spurt may do with the goal in view,
But steady's the word, say I.
Steady's the word that wins, Lad,
Grit and sturdy grain:
It's sticking to it will carry you through it—
Roll up your sleeves again.

Oh, Snap is a very good cur, Lad,
To frighten the tramps, I trow,
But Holdfast sticks like a burr, Lad—
Brave Holdfast never lets go.
And Clever's a pretty nag, Boy,
But stumbles and shies, they say;
So Steady I count the safer mount
To carry you all the way.

The iron bar will smile, Lad,
At straining muscle and thew;
But the patient teeth of the file, Lad,
I warrant will gnaw it through.
A snap may come at the end, Boy,
And a bout of might and main;
But Steady and Stick must do the trick—
Roll up your sleeves again.

EMPLOYMENT DEPARTMENT

¶TO EMPLOYERS—The editors of THE TECHNICAL WORLD will be glad to bring employers of skilled labor into communication with trained and efficient men. Write the Employment Department full particulars as to the qualifications necessary. ¶STUDENTS AND GRADUATES of the American School are entitled to one insertion under the heading "Situations Wanted," free of charge. Subsequent insertions must be specially ordered, and will be charged for at a nominal rate.

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WANTED—An Electrical Engineering student, age 31 years, with some experience as fireman and engineer, desires a position with an Electrical Company, either Manufacturing, Light, or Power; or as Assistant Engineer. A-1 references. Address *The Technical World*, No. 202.

WANTED—Position as Draftsman by an Englishman 21 years of age. Two years' training in Technical College of Engineering. Experienced. References. Least salary $50. Address *The Technical World*, No. 203.

WANTED—Position as Chief Engineer by Norwegian 27 years old. Seven years' experience. First Class license, Chicago, March 25, 1904. Salary $90. References. Address *The Technical World*, No. 204.

WANTED—An American 21 years of age with 3 years' experience wishes a position as Assistant in Electrical plant. References. Salary $50. Address *The Technical World*, No. 205.

WANTED—Position as Assistant Electrical Engineer. Graduate of Electrical Engineering course of the American School of Correspondence. Experience as foreman of construction. Three years' experience in Electric construction, repair and telephone work. References. Address *The Technical World*, No. 206.

WANTED—A man with 2 years' experience in operation of high-speed, simple engines, a graduate of the American School of Correspondence, desires position as Assistant Engineer in a power plant. Prefers as to location the Middle West. Salary $35 to start. Address *The Technical World*, No. 207.

WANTED—A student of the American School of Correspondence wishes a position in an up-to-date Foundry. Capable of starting a Core-Room System that will save time and money. Have had experience in this line. Prefer employment in the Eastern States. Address *The Technical World*, No. 208.

WANTED—A position in some line of Electrical work by a young man with 6 years' experience in "Baking." No practical experience in electrical work. Salary $9 per week. Address *The Technical World*, No. 209.

WANTED—A young man of one year's experience in street railway work, and 4 years' experience in inside wiring, installing motors and repairing same, desires a position in electric shop or operating department of an Electric Railway Company, Chicago. Will start at bottom. Address *The Technical World*, No. 210.

WANTED—Position as Assistant in Power House. Salary $35 per month. Experienced in construction and installation of telephones, telephone lines, switchboards, etc. Address *The Technical World*, No. 211.

WANTED—A position as Engineer or Superintendent of Electric Light and Water Works is wanted by a man with 7 years' experience. Salary $75 per month. Address *The Technical World*, No. 212.

WANTED—A student of the American School of Correspondence with 2 years' practical experience wishes position in machine shop under instructions. Speaks English and German. Location immaterial. Salary subject to circumstances. Best of references. Address *The Technical World*, No. 213.

WANTED—By young man of 19, a position as general assistant to an electrician or electrical engineer. Lowest salary accepted $35 per month. Address *The Technical World*, No. 214.

WANTED—A student of the American School wishes position as Air-Brake Repairman or Air-Brake Inspector. Has had 3 years' experience in Valve Repair Work. Salary $70 per month. Address *The Technical World*, No. 185.

WANTED—Position in some boiler or engine works is desired by a young man of 23. High School graduate and a student of the American School. Salary $6 per week. Address *The Technical World*, No. 186.

WANTED—A young stationary engineer desires position in Chicago or the Northwest. Has had some experience. Good habits. Single. Salary $60 per month. Address *The Technical World*, No. 182.

EMPLOYMENT DEPARTMENT—(Concluded)

WANTED—Position as Oiler or Helper in electric light plant or powerhouse. Student of the American School. Prefers work under engineer of technical training. Location Ohio or Western New York. References. Address *The Technical World*, No. 183.

WANTED—A position by a young man in either electrical or mechanical work. Electrical preferred. Willing to work for a small salary to start with. Address *The Technical World*, No. 175.

WANTED—Young man, inexperienced, but having a thorough knowledge of machinery, wishes position as Dynamo Tender. Would accept not less than $12.50 per week. Best of references furnished. Address *The Technical World*, No. 157.

WANTED—Position as apprentice in either electrical or mechanical work, electrical preferred. Position desired where a practical knowledge of the building of electrical machinery can be gained. Address *The Technical World*, No. 180.

WANTED—A position as chief engineer in a power house of 500 or 1,000 H. P., or as assistant in a large power house, by a young man 23 years of age. Has had 6 years' experience. Territory preferred, Iowa, Wisconsin, Illinois, or Nebraska. Salary not less than $900 per year. Address *The Technical World*, No. 181.

WANTED—A position as Stationary Engineer by a young man of 27 who has had seven years' experience in operating mining machinery, milling machinery, and various types of pumps, and in steam-fitting. Has good habits and can satisfy the most exacting employer with honest service. Salary not less than $18 per week. Address *The Technical World*, No. 176.

WANTED—Young man who is a surveyor would like a position where he can have a chance to work up in his profession—Civil Engineering. He is now taking a course in Hydraulics in the American School. Address *The Technical World*, No. 178.

WANTED—A young man of 26, 7 years' experience as machinist, and a graduate of the American School of Correspondence in Mechanical Drawing, desires a position at Drawing. Address *The Technical World*, No. 215.

WANTED — Student in Mechanical-Electrical Engineering wants position as Photographer and Draftsman. Thirty years of age. Ten years' photographic, four years' mechanical, experience. Address *The Technical World*, No. 216.

WANTED—An Electrical Engineer, graduate of the American School of Correspondence, desires a position as Stationary Engineer in a manufacturing plant or generating station. Six years' experience in Steam and Electricity. Salary $18 per week. Address *The Technical World*, No. 217.

WANTED—An Agency. Engineer of wide acquaintance, desires to represent manufacturers of high-grade Engines, Generators, and Motors, on the Pacific Coast. Address *The Technical World*, No. 221.

WANTED—Position as Electrical Repair man or Machinist in St. Paul or vicinity. Least salary accepted $12 per week. Three and one-half years' experience, and nearly completed the Mechanical-Electrical Course in the American School. 24 years old. Address *The Technical World*, No. 218.

WANTED—A young man with eight years' experience in all-round engine work and capable of taking charge of a small plant, desires a position as Fireman or Oiler. Salary $40. Location preferred—Kansas, Missouri, or Iowa. Address *The Technical World*, No. 219.

WANTED—Student in the Electrical Engineering Course wishes a position as Electrical Engineer. $75 per month. Three years' experience in charge of testing department of Simpley Elect. Mfg. Co. Six months' electrical contracting, one year electrical engineer. American. Age 29. Address *The Technical World*, No. 220.

WANTED—Position as Engineer's Helper is wanted by a young man of some experience in a small plant. Student of the American School of Correspondence. Least salary accepted $40 per month. Address *The Technical World*, No. 223.

WANTED—A student of the American School of Correspondence desires a position at Electrical work, with chance to get practical experience. Best of references. Address *The Technical World*, No. 224.

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BOOKS

Engineering Education. Volume XI of the "Proceedings" of the Society for the Promotion of Engineering Education. Published by the Engineering News Publishing Company. Pages 380. Price, $2.50.

TO ANYONE desiring the opinions of others on the subject of engineering education this volume is of great value. Articles on secondary schools, specialization, the equipment of the electrical laboratory, and the qualifications for graduates, are among the contents. The discussions following the papers are of nearly as much value as the papers themselves.

One of the questions confronting educators is—When shall specialization begin? In the secondary school, the first year in the technical school, or later? It seems that many in this society feel that the secondary school is too early, and with this we heartily agree. Others think the first year in the technical school is the proper time, but the question is raised—Is not this also too early?

In this volume is the list of books for a technical library as outlined by a committee chosen for the purpose. The idea is excellent, and the list includes many fine books. We should like to make one criticism, however. The list would be of greater value if in each case the name of the publisher were given, and the price, with the number of pages indicated. A paragraph explaining the scope would also add much to the working value. These facts are given in many cases, but should be stated in all.

Volumes of "Proceedings" of the Society may be purchased from the secretary, Clarence A. Waldo, Purdue University, Lafayette, Indiana; from the publishers, or through THE TECHNICAL WORLD. Price $2.50 per volume. Index covering the first 10 volumes, 50 cents.

Compendium of Drawing. Compiled from the Instruction Papers of the American School of Correspondence, Chicago, Illinois. Cloth. Pages 900. In two volumes. Price, $5.00 per volume; both volumes, $8.00.

THESE TWO VOLUMES contain the essentials of Mechanical Drawing, Machine Design, Sheet-Metal Pattern Drafting, and the portions of Architectural Drawing that come under the heads of Perspective, Shades and Shadows, Pen and Ink Rendering, and Architectural Lettering. The general scheme of dividing the subjects in the two volumes seems to be to place the portions relating to the artistic side of drawing together in Part I; and the more practical subjects—those used in engineering—in Part II.

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The first third of Part I takes up the elementary principles of Mechanical Drawing, including Geometric Drawing and Orthographic, Isometric, and Oblique Projections. The parts on Perspective and on Pen and Ink Rendering deserve highest praise. The discussion of values and accents under Rendering, is excellent.

Part II begins with working drawings, and is especially valuable to the shop draftsman. The Machine Design is preceded by excellent explanations of the principles of elementary mechanism—belts, gears, cams, screws, link work, quick-return motions, etc. An interesting problem in the Mechanical Drawing is that of cutting the belt holes in floors. The proper sizes and angles are laid out for both open and crossed belts.

Sheet-Metal Pattern Drafting first considers light metal—Tinsmithing—and then the heavier, such as is used in bath tubs, ventilators, and elbows. This section is very practical, the problems having been selected and worked out with greatest care.

A simple mention of some of the authors of these sections is a sufficient guarantee of the excellence of the work. Among these are: Professors Lawrence and Gardner, and David A. Gregg, of the Massachusetts Institute of Technology; Charles L. Griffin, Mechanical Engineer with the Semet-Solvay Company, formerly professor of Machine Design at Pennsylvania State College; Walter H. James, of the Massachusetts Institute of Technology; and William Neubecker, of the New York Trade School.

Twentieth Century Handbook for Engineers and Electricians. By C. F. Swingle, M. E. Pages 500. Frederick J. Drake & Co., Publishers. Price, $2.50.

THIS HANDBOOK has more explanations than are usually found in books of this nature. In place of the ordinarily excessive space devoted to facts, tables, or formulæ, reasons are given for doing things. At the end of each section there is a list of test questions. Over thirty pages are devoted to valves and valve setting, this portion of the work being of especial value. The last third of the book is the electrical section, which, in treatment, is similar to the steam section. The book is substantially bound in leather and presents a good appearance, although the illustrations might have been chosen with greater care.

Practical Lessons in Electricity. Published by the American School of Correspondence at Armour Institute of Technology, Chicago, Ills. Fourth edition revised. Price, $1.35.

THIS BOOK is made up of four Instruction Papers from the Electrical Engineering Course of the above-mentioned School, and forms a valuable reference work for the student or worker along electrical lines.

The section on Elements of Electricity, by Lawrence K. Sager, S. B., LL. B., takes up the principles of magnetism, static electricity, dynamic electricity, etc.

The section on the Electric Current by the same author takes up the many important calculations—in regard to Ohm's Law, resistance, current, electromotive force, etc.—to be met with in direct-current work. The numerous illustrative examples form a valuable feature of this section.

The section on Electric Wiring is by H. C. Cushing, Jr., the well-known author of "Standard Wiring for Electric Light & Power." It contains information of the utmost value to the electric wireman, inspector, architect, and builder, in regard to the installing of electrical machinery, and the wiring of buildings for both arc and incandescent lights and for electric power. The most common problems arising in this line of work are the calculation of drop and size of wire for a given load of lights, motors, or both; and the formulæ and tables given allow such calculations to be made rapidly and accurately.

The section on Storage Batteries is by Prof. F. B. Crocker, E. M., Ph. D., head of the Electrical Department of Columbia University, past president of the American Institute of Electrical Engineers, and is up to the high standard that would be expected from the pen of this well-known writer, teacher, and engineer. In it are taken up the fundamental principles of the storage battery, and the various types in common use; also a treatment of the management of storage batteries under

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different conditions of operation, troubles and remedies, various tests, applications, etc.; while the treatment of the subject of booster regulation is particularly worthy of mention. The satisfactory action and the life of the storage battery depend largely on the purity of the electrolyte; and Professor Crocker pays special attention to the common impurities found therein, their causes, and the methods of testing for determining their presence.

This book is worth several times over, the price charged for it, and is sold at a very low figure simply to furnish an opportunity to the public of judging the standard and scope of the instruction offered by this well-known School.

Electrical Designs. Reprinted from the American Electrician. McGraw Publishing Company. Price, $2.00.

THE CHAPTERS OF THIS BOOK are made up of articles that originally appeared in the *American Electrician*. They were written by the designers of the apparatus described, which in many cases had actually been built and used previous to the publishing of the description. The book contains designs for a number of useful and interesting pieces of apparatus, which can be made without great difficulty, explanations and dimensioned sketches being given for the apparatus described. If the instructions here given are followed carefully, they will result in practical working machines of sufficient size for experimental purposes and for study of the principles involved.

The book contains designs for various types of motors of between 1-6 horse-power and 3 horse-power; combined alternating-current and direct-current machines of from 1 to 4 kilowatts' capacity; a ¼ horse-power single-phase induction motor; simple transformer (4 sizes); voltmeters, ammeters, and wattmeters; various types of galvanometers; a storage battery; influence machine; etc.

A B C of the Telephone. By James E. Homans, A. M. Second edition revised. Pages 349. Theo. Odell & Company, Publishers. Price, $1.00.

AS THE NAME INDICATES, this is an elementary treatise. It is a book suited for the non-technical reader, and is written in simple and clear style, furnishing instructive and attractive reading for any one interested in the telephone.

The book discusses among other matters the theory of sound, upon which the operation of the telephone is based; and gives a brief discussion of the principles of electricity and electrical quantities. After this brief introduction, the telephone is taken up—first historically, and then from the standpoint of the actual working device. The transmitter, circuits, switch hook, etc., are of course treated, together with switchboard attachments, multiple switchboard, exchange battery system, etc. Several chapters have been rewritten or enlarged in this second edition, thus making a considerable improvement. The book is fairly well illustrated, and contains many diagrams and tables.

Roof Framing Made Easy. By Owen B. Maginnis. Pages 164. Price, $1.00.

How to Measure up Woodwork for Buildings. By Owen B. Maginnis. Pages 79. Price, 50 cents. The Industrial Publication Co.

THE ABOVE BOOKS are written so as to place reliable and valuable information, in a concise form, in the hands of builders and mechanics. The scope of "Roof Framing Made Easy" is seen when we mention that it contains thirty-three chapters. The first two deal with the principle of the roof, and general directions; the others take up in a most practical manner every form of roof, from the square pyramidical to the cantilever. This little work has had a large sale, and is now in its second edition.

"How to Measure up Woodwork for Buildings" contains valuable directions for measuring up the quantities of woodwork required for brick and frame houses. A careful reading of this book should reduce blunders in the ordering of material, to a minimum. Its chapters cover the measuring of doors and sashes, finding the dimensions of house fixtures, measuring stairs, etc.

The Railroad in Education. By Alexander Hogg, Fort Worth, Texas. Price, 50 cents.

PROF. ALEXANDER HOGG, the author of this very readable book, is Superintendent of Schools in Fort Worth, Texas.

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The germ of this work was a paper read before the Exposition in New Orleans in 1885, and shortly thereafter published in pamphlet form. Since its first appearance it has been revised and has passed through fifteen editions. The main purpose of the book is to trace the evolution of the railroad, and to exhibit its educational and civilizing force as a type of national progress and commercial enterprise.

The Art of Writing and Speaking the English Language. By B. Sherwin Cody. Three volumes. Vol. I, Word Study. Vol. II, Grammar. Vol. III, Composition. Vol. IV, Construction and Rhetoric. Price, $3.00 the set; 75 cents each volume. Published by the author.

IF THERE IS ONE THING more than another necessary for a man engaged in business of any kind, it is the ability to express his thoughts in letters or in speech, in good, clean, clear English. To be able to do this removes the possibility of scores of misunderstandings. It will also go far to help a man to promotion. To all who are weak in their English, we heartily recommend these four little books by Mr. Cody. They are above all things practical; the treatment of each subject is clear and simple. Their study will assist materially to a thorough command of English.

MAGAZINES

Amateur Work

THIS MAGAZINE is primarily for the amateur workman, for the boy having a few tools, and for the boy in the manual training school. The articles are practical, and in most cases the drawings are dimensioned. Several serials are now running, among which may be mentioned "Lantern-Slide Making," by R. G. Harris; "Pattern Making for Amateurs," by F. W. Putnam; "How to Build a Sailboat," by Carl H. Clark; "Printing for Beginners," by Frederick A. Draper.

"A Model Turbine Engine," by Arthur J. Weed, gives an amateur an opportunity to study this important type of engine by actually constructing one. Detailed directions are given. Other articles are:

A Rowing Skiff, by Carl H. Clark.
Lantern-Slide Holder, by E. E. Messenger.
Oil-Immersed Condenser, by Arthur H. Bell.
A Mercury Interrupter, by George J. Atkins.
A Chamber Set, by John F. Adams.
80-Watt Dynamo, by W. C. Houghton.

Cassier's Magazine

OF THE TECHNICAL ARTICLES in *Cassier's* for May, "Some Electric Furnace Processes," by J. Wright, is probably of the greatest value to most engineers. It deals with the use of electricity in many industries, such as the manufacture of calcium carbide, aluminum, carborundum, caustic soda from fused electrolytes, etc. The article is well worth preserving.

Other articles are:

Some Modern Quayside Cargo Appliances, by Brysson Cunningham, B. E., Inst. C. E.
Wasted Machinery on the Panama Canal, by George E. Walsh.
Fuel Economy in Steam Plants, by John B. C. Kershaw, F. I. C.
Water Hoisting Instead of Pumping, by R. V. Norris, Pa. R. R. Coal Companies.
Modern Gas Lighting, by W. H. Booth.
Scientific Work of the United States Navy, by Rear-Admiral C. M. Chester, U. S. N.
Special Machine Tools for Locomotive Shops, by Joseph Horner.

Power

SEVERAL ARTICLES in the May number of *Power* should interest the up-to-date steam engineer. "Two-Cycle *vs.* Four-Cycle Gas Engines" is a discussion of the advantages and disadvantages of these two types. Another good practical article is "The Care and Management of Leather Belts," by Walter E. Dixon, M. E.

Other articles are:

Indicator Spring Errors, by H. Boyd Brydon.
The Real Menace to Fly Wheels, by Wm. H. Boehm.
The Use and Abuse of Direct-Acting Steam Pumps, by W. H. Wakeman.
Setting up a Vertical Engine, by John F. Nagle.
Multiple-Impact Steam Turbine, by A. M. Levin.
Lubricating Oils and their Properties, by William Davis.

The Engineer

THE MAY NUMBER of *The Engineer* contains at least four articles of especial interest to steam engineers, and three for electrical engineers. Some steam traps are well described in an article by Walter

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W. Edwards. Mr. Charles L. Hubbard explains that troublesome point—the difference between the engine horse-power and the boiler horse-power. He also gives valuable ideas regarding the boiler horse-power necessary for heating and ventilation and for supplying power. While the measuring of indicator cards and the computing of the horse-power of an engine are familiar to many, yet we are always on the lookout for a chance to get new ideas and refresh our memory.

In this number, also, Mr. Kelly explains with care the planimeter and its vernier.

The article on the Gas Turbine is doubtless soon to be followed by others, as it seems improbable that the difficulties of developing this new motor will long trouble engineers. The gas engine, as well as the turbine, possesses distinct advantages, and a combination should result in an economical engine.

Three electrical articles are:

Elementary Principles of Alternating Currents. IV.—Self Induction, by Professor Tell.
Electric Traction with Alternating Currents, by A. Gradenwitz.
A Gas-Engine Lighting Unit, by J. B. Meriam.

Ice and Refrigeration

PROBABLY THE MOST VALUABLE article in the May number of this magazine is "The Ammonia Compressor of the Future," by F. E. Mathews. It includes a statement of the losses that reduce the efficiency of the ammonia machine. The new oscillating admission valve is mentioned, but its real advantage is yet to be demonstrated. "Ice Machine Parts," by T. R. Wingrove, is another article of interest to the refrigerating engineer.

Several serial articles appear, among which may be mentioned:

The Distilling Apparatus, by J. C. Bertsch.
Natural Ice Business.
The Carbonic Acid Industry, by J. E. Goosman, M. E.

Marine Engineering

THE MAY NUMBER contains a description of the 12,726-Mile Run made by the *Nebraskan*. This steamship covered the distance with an average speed of 10.35 knots. The fuel used was residuum oil. The trip added much to the data on oil as fuel, and proved that with oil a run can be made with greater certainty, for this vessel reached her destination on the day determined by previous calculation.

"The Design of a 6-Horse-power, Two-Cycle Motor," by H. B. Maxwell, is excellent. Dimensioned drawings of the details are given, and also an assembly drawing.

Other articles are:

Japanese Imperial Yacht *Hatsukaze*.
Gas and Oil Engines on Shipboard, by John E. Thornycroft.
The Central Superheater.
Steamer *Augustus B. Wolvin* of the Great Lakes.
Merchant Cruisers and Steamship Subsidies.
Steamers of Baltimore & Philadelphia Steamboat Company.
Launch of the U. S. Battleship *Virginia*.

CATALOGUES

Universal Drafting Machine Company, Cleveland, Ohio. Pages 16. Paper. 6 by 9 inches.

CATALOGUE DESCRIBING A DEVICE that is a mechanical aid to the draftsman. The machine is illustrated in several positions showing its adaptability to mechanical, architectural, and structural work.

De Laval Steam Turbine Company, New York City. Pages 52. Paper. 6 by 9 inches.

FOLLOWING A BRIEF HISTORICAL SKETCH, the De Laval turbine is illustrated and described. The advantages are classified and discussed under these headings. The details of the working parts are well shown by half-tone engravings.

Northern Electrical Manufacturing Company, Madison, Wis. Bulletin No. 30. Pages 32. Paper. 7 by 10 inches.

THIS BULLETIN describes direct-current generators. The detailed illustrations of the bearings, armatures, pole pieces, fields, etc., are principally half-tones. Bulletin No. 35, 36 pages, illustrates multipolar motors, open and enclosed types. The applications to lathe work, elevator service, radial drills, punch presses, etc., are pointed out and illustrated.

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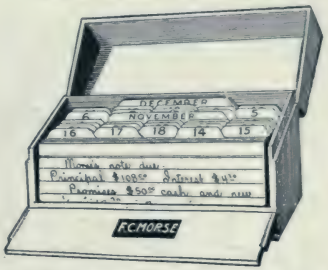

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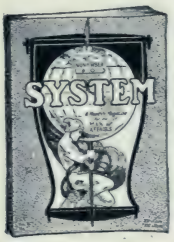

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LITERATURE—(Concluded)

Luther L. Miller, Chicago, Illinois. "Trade Marks." Pages 32. Paper. 5 by 6 inches.

A UNIQUE BOOKLET explaining the law of trade marks of the United States and foreign countries. "Commercial Importance," "Trade Rights in the United States," and the "United States Revised Statutes" are among the subjects treated.

Lodge & Shipley Machine Tool Company, Cincinnati, Ohio. Pages 80. Paper. 6 by 9 inches.

CATALOGUE OF LATHES AND ATTACHMENTS designed especially for high-speed steels. Illustrated by excellent half-tone engravings and line drawings of details—Engine Lathes 14-inch to 48-inch; Turret lathes; combination of Engine and Turret; and attachments.

The Standard Tool Company, Cleveland, Ohio. Pages 224. Paper. 4 1-2 by 7 inches.

CATALOGUE of Twist Drills, Reamers, Spring Cotters, Taps, Keys, Milling Cutters, and other Tools. The catalogue also contains tables such as decimal equivalents, standard screw threads, wire gauges, metric system, etc.

Brown-Corliss Engine Company, Milwaukee, Wisconsin. Pages 48. Paper. 7 by 10 inches.

CATALOGUE of Brown-Corliss engines, showing horizontal and vertical types, both cross- and tandem-compound. The details, especially the valve gear, are well illustrated by half-tone engravings. This company makes both single and double eccentric engines. In addition to the above-mentioned engines, they build blowing engines, rolling-mill engines, mining machinery, compressors, and gas engines.

The Green Fuel Economizer Company, Matteawa, N. Y. Pages 96. Paper. 6 1-2 by 9 1-2 inches.

THE CONSTRUCTIVE DETAILS of the economizer are first explained, special attention being given to the scrapers and reversing gear. The results of tests, illustrations of installations, and a list of companies using the Green Economizer, form a large portion of the catalogue.

Garvin Machine Company, New York City. Pages 210. Paper. 4 by 7 inches.

CATALOGUE of milling machines, lathes, and their parts and attachments. A large variety of index centers, milling cutters, cutter grinders, etc, are shown. Calculations and simple rules for gearing up engine lathes for screw-cutting, and for spirals on dividing head, are also given.

Olds Motor Works, Lansing, Michigan. Pages 36. Paper. 6 by 9 inches.

CATALOGUE on gas and gasoline engines. The Olds engine is illustrated by several full-page cuts showing various views and sizes. The details—connecting rod, crank, cylinder, spark igniter, etc.—are explained and illustrated.

Reeves Engine Company, Trenton, N. J. Pages 48. Paper. 6 by 9 inches.

THE REEVES COMPOUND ENGINES are described in a neat catalogue printed on coated paper. The excellent half-tones, especially the sections, add much to the attractiveness of the catalogue. This company make vertical and horizontal compound engines for belted and direct connection.

Kellogg Switchboard & Supply Company, Chicago, Illinois, U. S. A. Magneto Switchboards. Pages 103. Size, 6 1-2 by 9 inches.

THIS CATALOGUE follows the bulletin mentioned in our May number on the Magneto Telephone, and describes the workings of the small switchboards of the Kellogg Company. It is often possible to find more practical up-to-date information in a well-planned catalogue than in a textbook, and any one interested in switchboards would find this pamphlet very interesting and instructive. It is well illustrated, and contains numerous diagrams. Among the subjects taken up are express type switchboards; combined drops and jacks; combined ringers and jacks; cord circuit apparatus; operators' circuit apparatus; and other accessories of the switchboard.

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